DEC STD 052-1 Operational Requirements for Serial Terminals and Serial System Interfaces Operating as DTEs Connected to EIA/TIA-232-E or CCITT V.28

DOCUMENT IDENTIFIER: A-DS-EL00052-01-0000 Rev D, 09-Sep-1991

ABSTRACT: This standard defines the operational interface characteristics of serial terminals and serial system interfaces operating as manual originate or answer or as automatic answer data terminal equipments (DTEs) connected to either "data leads only" or "full-modem control" point-to-point modems (DCEs) whose interfaces generally conform to EIA/TIA-232-E or CCITT recommendation V.28. This standard also covers manual and automatic disconnection of the DTE at the end of a call.

APPLICABILITY: This standard is mandatory for all Digital personnel involved in the design of communication interfaces and communication software. Nonconformance with this standard cannot be waived unless a waiver to DEC STD 062-0 Product Submittal To Regulatory Agencies and DEC STD 062-2 German EMI Certification/Approval Process.

STATUS: APPROVED 09-Sep-1991; use VTX SMC for current status.

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Responsible Person: Jan Purwin

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Jan Purwin - Backbone Network Product Engineering

Eric Williams - Standards Process Manager

Direct requests for further information to:

Jan Purwin
Use $ VTX ELF for the latest location information.

Use VTX SMC to order copies of this document from Standards and Methods Control. Send distribution questions to JOKUR::SMC or call DTN: 234-4423.

CONTENTS

1 INTRODUCTION 1
1.1 PURPOSE 1
1.2 SCOPE 1
1.2.1 Nongoals 1
1.2.2 Assumptions 2
1.3 RESPONSIBILITIES 2
1.3.1 Designers 2
1.3.2 All Employees 2
1.4 TERMINOLOGY 2
1.5 COMMUNICATION SYSTEM SUMMARY 4

2 MODES OF OPERATION 6
2.1 MODES SET AT INSTALLATION 6

3 FULL-DUPLEX (TWO-WAY SIMULTANEOUS) 8
3.1 INTERFACE SIGNALS 8
3.2 STATE DIAGRAMS AND TABLE FOR FULL-DUPLEX MODE 10
3.3 TIMER REQUIREMENTS FOR FULL-DUPLEX OPERATION AND THEIR FUNCTIONS 10
3.4 STATE DIAGRAM — OVERVIEW 12
3.5 NOTES TO THE STATE DIAGRAM AND EXPLANATIONS 15
3.5.1 Power-Off State 1 15
3.5.2 Power-On State 2 15
3.5.3 DTE Faults 15
3.5.4 DTE Off-Line State 15
3.5.5 On-Line Idle State 3 15
3.5.6 On-Line Originate State 5 16
3.5.7 DCE Setup 17
3.5.8 Call-Connecting State 10 18
3.5.9 Data Transfer State 7 18
3.5.10 Disconnect State 8 18
3.6 DATA SIGNALING RATE SELECTOR 19
3.7 ADDITIONAL FEATURES 19

4 POINT-TO-POINT, FULL-DUPLEX OPERATION 20
4.1 GENERAL 20
4.2 TIMER REQUIREMENTS FOR FULL-DUPLEX, POINT-TO-POINT OPERATION AND THEIR FUNCTIONS 20
4.2.1 Power-Off State 1 23
4.2.2 Power-On State 2 23
4.2.3 DTE Faults 23
4.2.4 DTE Off-Line State 23
4.2.5 Off-Line State 23
4.2.6 On-line Idle State 3 24
4.2.7 Data Transfer State 7 24
4.2.8 Disconnect State 8 25

5 INTERCHANGE CIRCUIT REQUIREMENTS FOR FULL-DUPLEX OPERATION . . . 26

6 HALF-DUPLEX (TWO-WAY ALTERNATE) 29
6.1 GENERAL 29
6.2 TIMER REQUIREMENTS FOR HALF-DUPLEX WITH DCE SETUP/PSTN OPERATION 29
6.3 STATE TABLES FOR HALF-DUPLEX OPERATION 30
6.4 STATE DIAGRAM - OVERVIEW 34
6.4.1 Power-Off State (DTE Only) 34
6.4.2 Power-On State 34
6.4.3 DTE Faults 34
6.4.4 On-Line Idle State 3 34
6.4.5 On-Line Originate State 5 35
6.4.6 On-Line Answer State 4 36
6.4.7 Call-Connecting State 10 36
6.4.8 Protocol Module 36
6.4.9 Receive Enable State 7R1 36
6.4.10 Receiving State 7R2 36
6.4.11 Transmit Enable State 7T1 37
6.4.12 Transmitting State 7T2 37
6.4.13 Data Mode Receive 37
6.4.14 Disable Receive State 37
6.4.15 Disconnect State 8 37
6.5 INTERFACE SIGNAL REQUIREMENTS 38

7 POINT-TO-POINT OPERATION 40
7.1 GENERAL 40
7.2 TIMER REQUIREMENTS FOR POINT-TO-POINT, HALF-DUPLEX OPERATION 40
7.3 STATE DIAGRAM - OVERVIEW 43
7.3.1 Power-Off State 43
7.3.2 Power-On State 43
7.3.3 DTE Faults 44
7.3.4 On-Line Idle State 3 44
7.3.5 On-Line Originate State 5 44
7.3.6 On-Line Answer State 4 45
7.3.7 Call-Connecting State 10 45
7.3.8 Protocol Module 46
7.3.9 Receive Enable State 7R1 46
7.3.10 Receiving State 7R2 46
7.3.11 Transmit Enable State 7T1 46
7.3.12 Transmitting State 7T2 46
7.3.13 Data Mode Receive 46
7.3.14 Disable Receive State 46
7.3.15 Disconnect State 8 46
7.4 INTERFACE SIGNAL REQUIREMENTS 47

8 MULTIPOINT 48

8.1 GENERAL 48
8.1.1 Multipoint Master 50
8.1.2 Multipoint Slave 50
8.2 INTERCHANGE CIRCUITS REQUIRED 51

9 DATA LEADS ONLY 52
9.1 GENERAL OVERVIEW 52
9.2 DATA LEADS ONLY 53
9.3 INTERCHANGE CIRCUITS REQUIRED 53

10 BIT RATES AND STOP ELEMENTS 54
10.1 BIT RATE SELECTION 55
10.2 HIGH-SPEED DATA RATES ABOVE 19200 BPS 56

Appendix A MANUAL CALL ESTABLISHMENT OPERATION 57

Appendix B MODEM CONTROL SIGNAL LEADS 59

B.1 MODEM CONTROL LEADS 61

B.2 MODEM CONTROL SIGNAL LEADS 61

Appendix C REFERENCED DOCUMENTS 63

C.1 EL-Class Digital Documents 63

C.2 Other Digital Documents 63

C.3 Other Documents 63

FIGURES

1 Coverage of this Standard 4
2 Mode Selection Guide 7
3 Minimum Implementation of V.24 Circuits for Full-duplex, Full-modem Control with DCE Setup 9
4 Modem Control for Two-way Simultaneous DTE 14
5 Modem Control for Full-Duplex, Point-to-Point 21
6 State Diagram for Half-Duplex 33
7 State Diagram for Half-Duplex, Point-to-Point Operation 41
8 Timing Default Diagram 48
9 Multipoint, Primary Full-Duplex, Secondaries Half-Duplex 49
10 Multipoint, Primary and Secondaries Half-Duplex 49
11 Flow Diagram - Data Leads Only 52

TABLES

1	State Table for Full-duplex with Network Addressing	11
2	State Table for Full-Duplex, Point-to-Point	22
3	EIA/TIA-232-E/V24-V28 Interface Assignments and Requirements	26
4	Pinning Requirements for V10/V11 Interface	27
5	Pin Numbers and Circuits for V.35 Interface	28
8	State Table for Half-Duplex with Network Addressing	30
7	Interface Signals for EIA-449	39
8	State Table for Half-Duplex	42
9	Multipoint Interface Signals and Pinouts	51
10	Bit Rate Selection	55
11	CCITT Interchange Circuit Numbers and Names	61

1 INTRODUCTION

1.1 PURPOSE

The purpose of this standard is to ensure that Digital designed serial interfaces (hardware, microcode, and software) operate satisfactorily when connected to all serial data communication equipment (DCE) in common use throughout the world.

Products designed to this standard will meet the currently known communications interface functional requirements of administrations worldwide.

To obtain approvals to operate on these networks, electromagnetic interference (EMI)/ radio frequency interference (RFI), safety, and other requirements must be met. For details, refer to *DEC STD 060-0 Design of Hardware Products to National and International Regulations and Standards, Policies and Procedures*. Also see *Producing International Products Reference Set*, EL-SM498-00.

1.2 SCOPE

This standard presently applies to full-duplex (two-way simultaneous) and half-duplex (two-way alternate) serial terminals and computer interfaces, synchronous and asynchronous. The terminals and interfaces may control the DCEs that operate over a Public Switched Telephone Network (PSTN), Public Switched Data Network (PSDN), or point-to-point circuits.

The interfaces must conform to Interface Between Data Terminal Equipment and Data Circuit - Terminating Equipment Employing Serial Binary Data Interchange (EIA/TIA-232-E) and/or International Telegraph/Telephone Consultative Committee (CCITT) V.24/V.28 recommendations for low speeds, (below 19.2 kb/s), or RS-423, RS-422, V.36, V.10, V.11 or V.35 recommendations for synchronous operation and speeds in excess of 19.2 kb/s.

Conformance to this standard will allow satisfactory operation of data terminal equipment (DTEs) with connections by way of a null modem to another DTE (computer, and so forth) that have EIA/TIA-232-E or CCITT V.24 interface sequences. Conformance to this standard may allow satisfactory operation of the DTEs with non-modem data concentrators that have EIA/TIA-232-E or CCITT V.24 interface sequences.

This standard (as of its approval date) shall apply to all designs within its scope that are started after its approval date. In addition, it may be advisable to redesign some equipment to meet this standard, due to marketing considerations.

This standard presently defines known requirements of common DCEs conforming to V series recommendations or EIA/TIA-232-E interfaces.

1.2.1 Nongoals

It is not expected that this standard will ever include:

a. Error detection and correction protocols

b. Parallel interface

c. X-series interfaces (other than X.20 bis and X.21 bis)

These areas are or will be the subject of other Digital standards when required.

1.2.2 Assumptions

This standard is based on the following assumption:

All terminals and system interfaces to which this standard applies (see subhead 1.2) will be used on a public switched telephone or data network, as well as in other applications.

If this assumption is not true for a particular product, then one or more requirements of this standard are not valid for that product. See *DEC STD 052-4 Local Direct Connection (No Modem) for Serial Asynchronous Terminals and System Interfaces* for the requirements for products that are only intended for Data Leads Only operation. For these operations, contact the maintainer of this standard for guidance and to have this standard revised.

1.3 RESPONSIBILITIES

1.3.1 Designers

It is the responsibility of every designer of a DTE or DCE interface that falls within the scope of this standard to conform to the requirements of this standard. Proposed or implemented terminal interfaces that do not satisfy the scope and requirements of this standard must be approved through the waiver process or be submitted in a revision proposal to this standard through an Engineering Change Order (ECO).

1.3.2 All Employees

It is the responsibility of any Digital employee (particularly Sales and Customer Services personnel) who becomes aware of a deficiency in this standard, to notify the maintainer of this standard of the deficiency, preferably with a suggested correction. Deficiencies can be caused by oversight, by the appearance of a new DCE with which equipment covered by this standard ought to interface, or by the implementation of new regulations that equipment covered by this standard must meet.

1.4 TERMINOLOGY

In this standard, the words *shall* and *must* are used to state requirements on the DTE that are minimum and absolute.

In this standard, the words *should*, *can*, *could*, and *may* are used to state recommendations that a DTE needs for the most effective operation.

In this standard, the word *will* is used to describe the operation of modems that a DTE (terminal or computer interface) will experience. The operation of modems is not defined by this standard and, in fact, is rarely under the control of Digital. However, there is a substantial amount of similarity among modems, that is described by *will* in this standard and makes this standard possible.

In this standard, the word *maximum* shall denote a value that a measurement shall not be greater than. *Maximum* is used in an algebraic sense; therefore, a voltage of -7.3 volts complies with a requirement of -5.0 volts maximum.

In this standard, the word *minimum* shall denote a value that a measurement shall not be less than. *Minimum* is used in an algebraic sense; therefore, a voltage of -7.3 volts complies with a requirement of -15.0 volts minimum.

The term *full-duplex*, when used in this standard, has the same meaning as *two-way simultaneous*. The term *half-duplex* has several meanings when used in industry. Its use in this standard will be defined where the term is used.

The signal naming convention used in this standard is in the format:
CCITT_Digital abbreviation — for example: 108_DTR or 107_DSR.

The term *DTE* is used for terminal equipment, such as terminal, personal computer, terminal server, VAX ™ serial line interface equipment, and so forth. The DTE is often referred to as a data source, a data sink, or both.

- A data sink is a functional unit that only accepts data (printer).
- A data source is a functional unit that originates data for transmission (terminal).

Data communication equipment *(DCE)* provides signal conversion and coding between the DTE and a communication link.

Such a link can be serviced by analog modems for voice band, broadband modems, or Digital service units (DSU).

In this standard, the term *mode* is used to describe operations such as full-duplex, half-duplex, or multipoint.

The term *service* is used to describe synchronous or asynchronous operations.

The term *state* is used to describe different states within a mode of operation.

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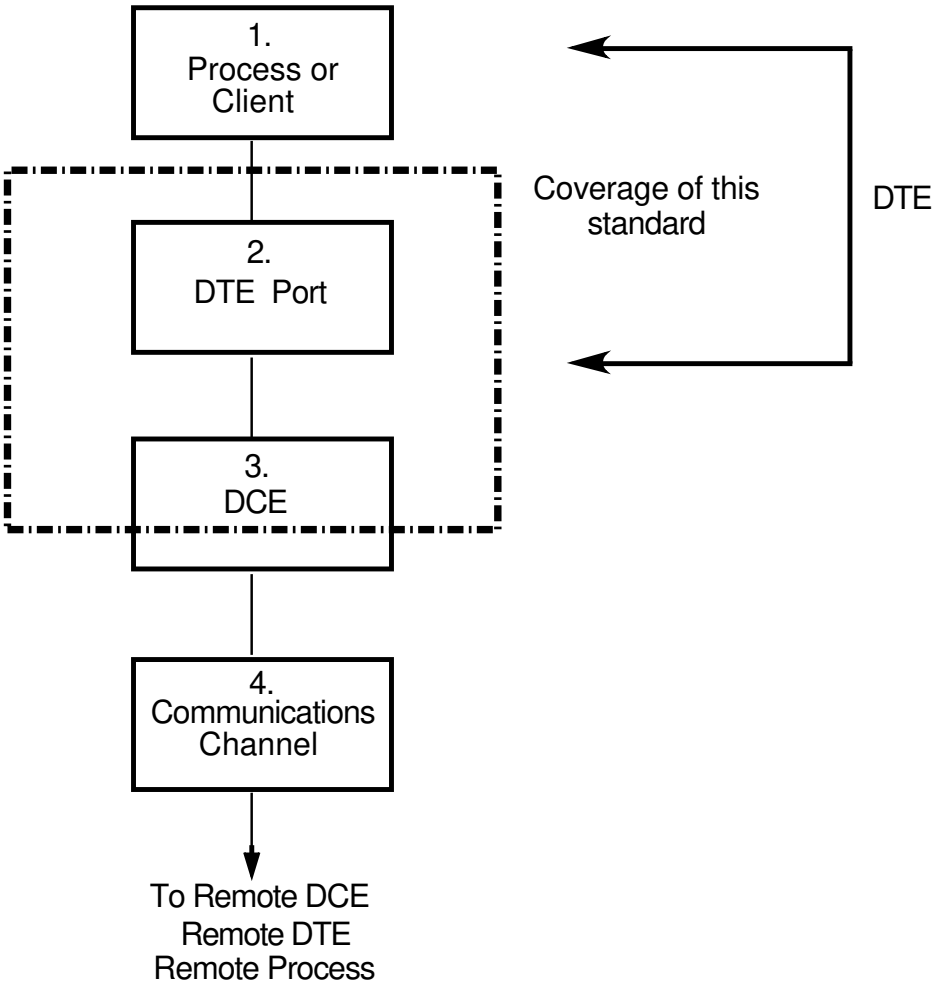
1.5 COMMUNICATION SYSTEM SUMMARY

The communication system in the context of this standard is shown in Figure 1. This standard covers functional operation of interface as shown by the dotted line in Figure 1.

Figure 1: Coverage of this Standard



The communications system contains the following elements:

Local DTE:

- Process or client
- DTE with associated port(s)

Communication channel:

- DCE
- Remote DCE

Remote DTE:

- Remote DTE with associated port
- Remote process or client

NOTE

For more information refer to DECnet Digital Network Architecture Modem Connect Functional Specification. For internal source should contact John Harper; see VTX ELF for location information.

The following brief summary of the communication system elements provides additional information.

Process or client — A software, firmware, or occasionally, hardware application that requires service from a port. The process is required to configure the DTE port for intended application. Application software maybe remotely located from DTE.

DTE — A device that provides, on one side, physical connection to the DCE, and on the other side, provides an interface to the process or client. The DTE is capable of determining conditions of the DCE and associated communication channel, and reporting these conditions to the attached client.

DCE — A device that provides the interface to the communication channel. It determines suitability of channel for data transfer and responds to the requests and stimuli from the DTE.

Communication channel — The communication channel provides a means of data transmission between DCEs.

Private line (also known as point-to-point) — The point-to-point line is one that connects exactly two end points and provides open channel for communication at the time of installation.

PSTN, GSTN - Public Switched Telephone Network.

2 MODES OF OPERATION

2.1 MODES SET AT INSTALLATION

The modes, described in the following list, are normally fixed (determined) at the time the equipment is installed, and are changed only upon re-installation or re-application of the equipment. The following mode or modes shall be provided in every product that is intended to connect to wide area communication equipment. Wherever equipment is designed to support one of the modes (minimum requirement) or all modes, then that section fully applies to the product, for example, asynchronous-only interface or synchronous-only interface. The implementation of the modes solely depends on product function and intended use. For business reasons, it is perfectly correct to select only one mode of operation and not to provide others.

- Full-modem control, asynchronous or synchronous, full-duplex with modem-controlled DCE setup (PSTN dial-in and dial-out).
- Full-modem control, asynchronous or synchronous, full-duplex without modem-controlled DCE setup (point-to-point operation and human-mediated dial-out).
- Full-modem control, asynchronous or synchronous, half-duplex with modem-controlled DCE setup (PSTN dial-in and dial-out).
- Full-modem control, asynchronous or synchronous, half-duplex without modem-controlled DCE setup (point-to-point operation and human-mediated dial-out).
- Full-modem control, asynchronous or synchronous, multipoint, master (primary) or slave (tributary).
- Data Leads Only (DLO), full-duplex, asynchronous, for DTE to DTE — see DEC STD 052-4 for details of local-only application.

  DLOs can be used with modems needing human interaction, such as a VT100 ™ terminal, but are not recommended to be used with computers due to a lack of control or modem hang-up procedure. DLO to a modem in a public network is forbidden in much of the world by government regulation.

NOTE

The full-modem control, full-duplex, or half-duplex with DCE setup/dial-out mode takes into account that a link between two DCEs is not present. This mode is substantially different from point-to-point mode because it requires that the process or client must establish a valid link before data exchange can take place. That type of operation has not been fully covered in previous versions of this standard.

In the point-to-point environment, communication can be sustained without establishing a connection; the physical link is established at the time of installation.

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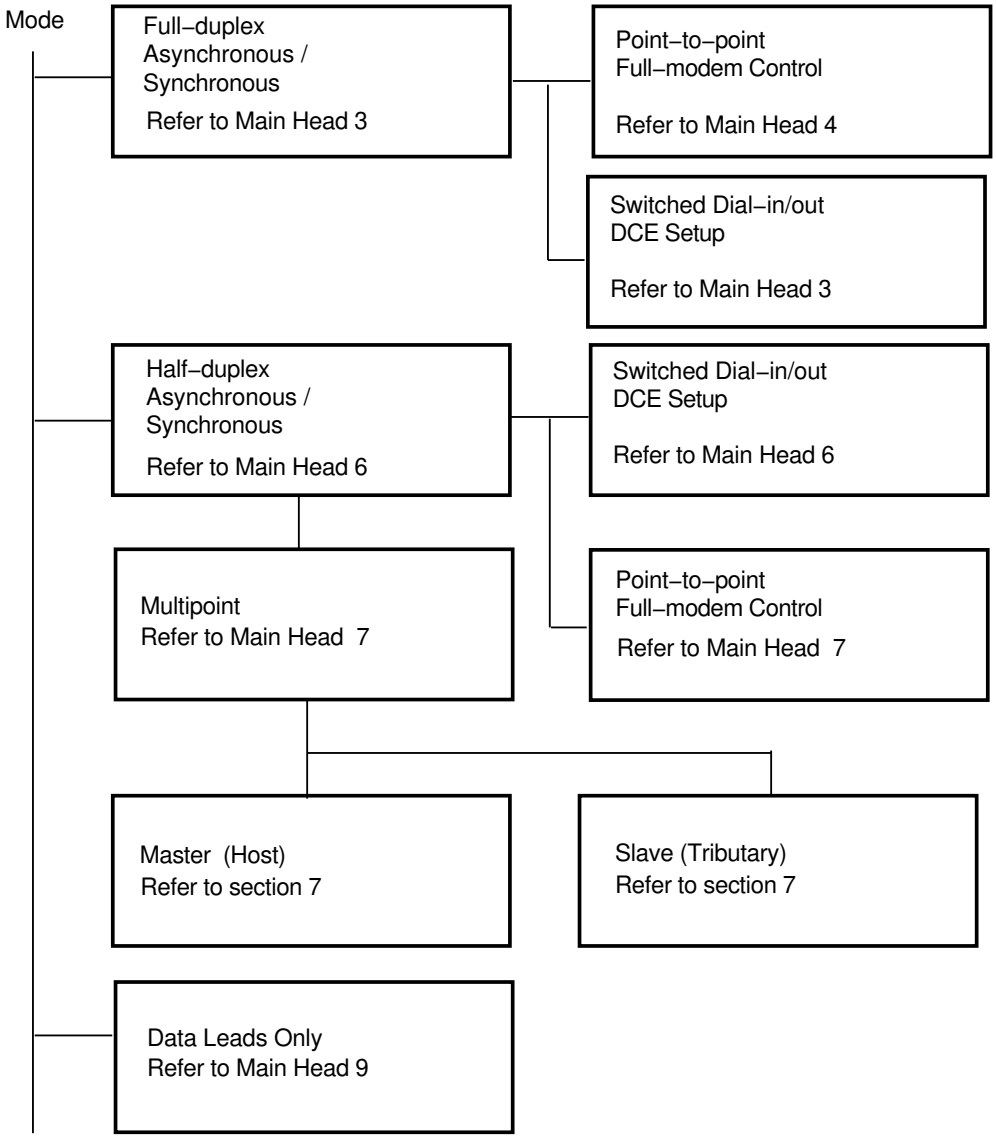
Figure 2: Mode Selection Guide



NOTE

DCE setup/dial-out means sending to the DCE from the DTE American Standard Code for Information Interchange (ASCII) strings that contain information to dial the phone number in the PSTN and the destination address in a PSDN.

3 FULL-DUPLEX (TWO-WAY SIMULTANEOUS)

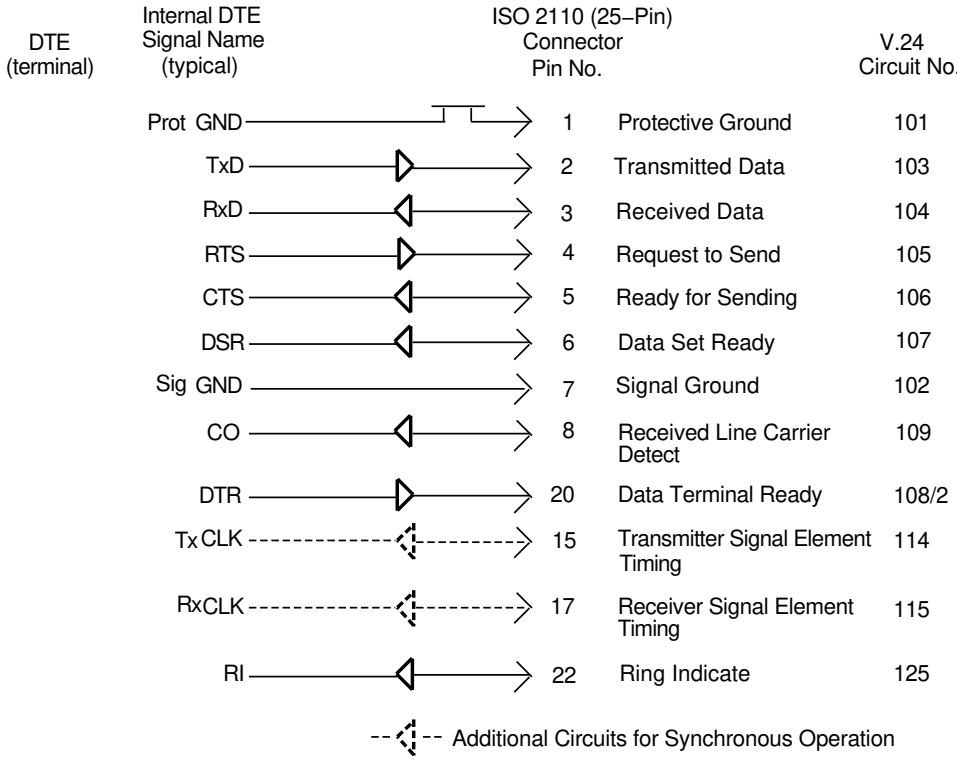
3.1 INTERFACE SIGNALS

In this section, it is assumed that a DTE with full-modem control is being designed for use with two-way simultaneous, asynchronous or synchronous, symmetrical transmission, and that all DTE modem signal connection requirements are met.

The full-duplex asymmetrical operation can be accomplished with a DTE that is capable of setting its transmit and receive speed to two different rates (1200/75 bps). Such a mode exists only in the asynchronous environment. The "handshaking" and associated state diagram is the same, regardless of transmit or receive speeds. With this assumption, a straight-through cable is required for connection to the DCE (modem).

For information on interfaces complying with EIA/TIA-232-E and V.24/V.28, refer to *DEC STD 052-0 Operational Requirements for Serial Terminals and Computer Interfaces Operating as DTEs Connected to EIA RS-232-C or CCITT V.28 Modems*. Refer to the proper specification mentioned previously for the electrical requirements of V.10, V.11, V.35, RS-422 or RS-423. Refer to DEC STD 052-4 for electrical overstress (EOS) and electrostatic discharge (ESD) protection.

Figure 3: Minimum Implementation of V.24 Circuits for Full-duplex, Full-modem Control with DCE Setup



*Note: Ring Indicate is required signal for dial–up modem operation.

3.2 STATE DIAGRAMS AND TABLE FOR FULL-DUPLEX MODE

NOTE

The state tables and diagrams used in this version convey the same information and requirements as in previous versions of this standard. The additional information that is presented in this standard is related to V.25 bis type of dial-out operation. The detail handshaking and flow diagrams are presented in *DEC STD 052-3 Automatic Calling and/or Answering Equipment on the GSTN Using the 100-Series Interchange Circuits*.

The state diagrams in this standard are modeled after the state diagrams that appear in the CCITT Blue Book. The state tables are for the purpose of enhancing readability and provide a guideline to the designer.

The state transitions can occur as a result of process or client action or because of network actions.

3.3 TIMER REQUIREMENTS FOR FULL-DUPLEX OPERATION AND THEIR FUNCTIONS

A few timers are required when implementing full-duplex mode intended for operation over PSTN with DCE setup.

T1 Timer 60 seconds ±10% DCE Timeout

This timer is required for operation with autodialing modems, and it is required by Germany. The timer guards against hang-up if the DCE will not respond to the command. The DTE transitions through State 8 (Disconnect) and returns to On-line Idle state.

T2 Timer 60 seconds ±10% False Call Timer

This timer guards against non-data calls to the DCE. Upon expiration of this timer, the DTE transitions by way of State 8 (Disconnect) to On-line Idle state.

T3 Timer 1 second ±10% Autocall Timer

This timer protects the DTE from entering into lockup condition when 106_CTS is not raised by the DCE; not allowing autodialing or DCE setup.

T4 Disconnect Timer 2 to 5 seconds 20% Disconnect Timer

This timer assures that the DTE will drop 108_DTR for a period of 2 to 5 seconds, allowing the DCE to disconnect from the telecommunication channel, clear the link, and not issue any commands to the DCE during that time. The 107_DSR should go to off condition unless it is operating in a nonstandard way. Upon expiration of T4, the DTE enters On-line Idle state.

T5 Timer 2 second ±20% Carrier Loss Timer

Upon expiration, this timer causes the DTE to transition into the Disconnect state.

Table 1: State Table for Full-duplex with Network Addressing

Old State	New State	Event
Power-off (1)	Power-on (2)	The power is applied to the equipment and interface circuits; internal diagnostics are enabled. All DTE circuits must be in the off state. 103_TD must be at MARK.
Power-on (2)	On-line Idle (3)	Transition to this state is initiated by the DTE. Diagnostics and Initialization procedures are completed. The DTE may be assigned to the process or client.
On-line Idle (3)	On-line Answer (4)	Transition to this state is caused by the DCE when 125_RI is on. The Call Answer procedure is initiated. 125_RI is on. Start the T2 False Call Timer.
On-line Idle (3)	On-line Originate (5)	The DTE initiates transition to this state. Call Initiate procedure has started. The DTE sends commands to the DCE and waits for a reply; the DTE starts the T1 DCE Timeout Timer. At the end of the command string sent to the DCE, the DTE resets the T1 Timer when a reply is received from the DCE. Upon completion of the dialing sequence and receipt of final acknowledgment from the DCE, the DTE starts the T2 False Call Timer.
On-line Originate (5)	On-line Answer (4)	The DCE causes transition to this state. Call collision is detected; abort the Call Initiate procedure. Abort the T1 and T2 Timers. Initiate the Call Answer procedure; 125_RI is on. Start the T2 False Call Timer. The DCE will force transition to State 4 and will proceed with execution unless the DTE (process or client) forces the transition to Disconnect State 8.
On-line Originate (5)	Disconnect (8)	The DTE initiates this transition. The T3 (Autocall) Timer expired or the T2 Timer expired before the DCE raised 106_CTS and/or 108_CD.
On-line Originate (5)	Call-connecting (10)	The DCE causes transition to this state. The Dial-out procedure is completed with success. Initiate the T2 False Call Timer (60 seconds). The DTE monitors 107_DSR, 109_CD, and 106_CTS.
On-line Answer (4)	Call-connecting (10)	The DCE causes transition to this state. Answer procedure is completed. Initiate the T2 False Call Timer. 107_DSR comes on. The DTE monitors 106_CTS and 109_CD.
Call-connecting (10)	Data Transfer (7)	The DCE causes transition by having both 109_CD and 106_CTS on. Abort the False Call Timer. The DTE is ready for data exchange. Transmit when 106_CTS is on; Receive when 109_CD is on.

Table 1 (Cont.): State Table for Full-duplex with Network Addressing

Old State	New State	Event
Data Transfer (7)	DCE Test Mode (9)	The DCE has been put in test mode, either by the operator or by a remote command. The client must suspend regular operation and initiate the Diagnostics procedure, if required. 142_TM is on. 107_DSR can be off if the associated DCE is in LOOP 2 (remote digital loop), or 107_DSR is on if LOOP 1 (local analog loop) or LOOP 4 (remote analog loop) is initiated. See V.54 recommendations for further reference.
Data Transfer (7)	Disconnect (8)	DCE-caused transition: Link failure is detected by 109_CD; off more than 2 seconds (the T5 Carrier Loss Timer expired) or the link was cleared by the DCE. 107_DSR is off. DTE-caused transition: The client initiated the DTE Disconnect procedure. Start the T4 Disconnect Timer (5 seconds). Set 108_DTR to off. Set 103_TD to MARK.
DCE Test (9)	Data Transfer (7)	The DCE completed the Diagnostics procedure or Test procedure; 142_TM is off and allows the client to resume regular operation.
DCE Test (9)	Disconnect (8)	The DCE initiates transition to the Disconnect state by turning off 142_TM and 107_DSR; the DTE starts the T4 Disconnect Timer.
On-line Answer (4)	Disconnect (8)	The DTE initiates transition to the Disconnect state by turning off 108_DTR and not accepting the incoming call. The DTE starts the T4 Disconnect Timer.
On-line Originate (5)	Disconnect (8)	The DTE initiates transition to the Disconnect state by turning off 108_DTR, or the T1 Timer expired; the DTE starts the T4 Disconnect Timer.
Call-connecting (10)	Disconnect (8)	The T2 False Call Timer expired. The connection is unsuccessful, or Call Originate/Answer procedures are unsuccessful.
Disconnect (8)	On-line Idle (3)	The DTE Disconnect procedure is completed. The T4 Disconnect Timer expired. Set 108_DTR to on; 105_RTS to on.

3.4 STATE DIAGRAM — OVERVIEW

This diagram shows the essential parts of full-duplex operation with information about states of control leads between the DTE and DCE. The signal states are shown in the bottom part of the box. The *1* designates that the particular control signal is on; the *0* designates that the signal is off, and the *x* designates *don't care* state. The DTE control signals are in the upper portion of the box. The corresponding DCE control signals are shown below the DTE signals. The *transition from one state to another* is being initiated

by either a change of lead status or by the expiration of a required timer. The timer values and names are shown on the corresponding transition line.

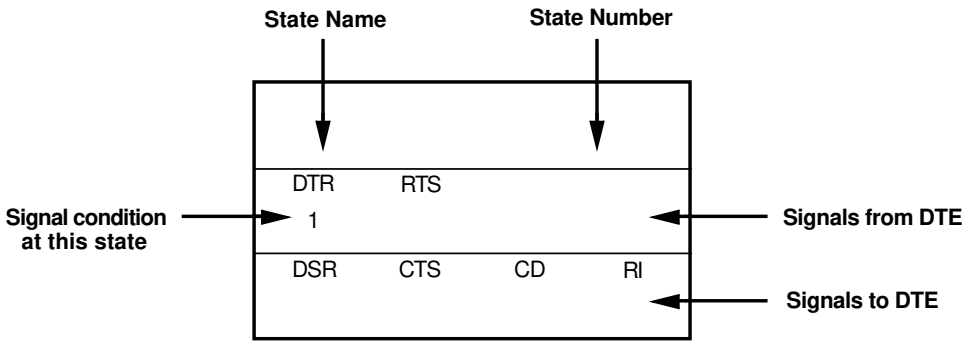
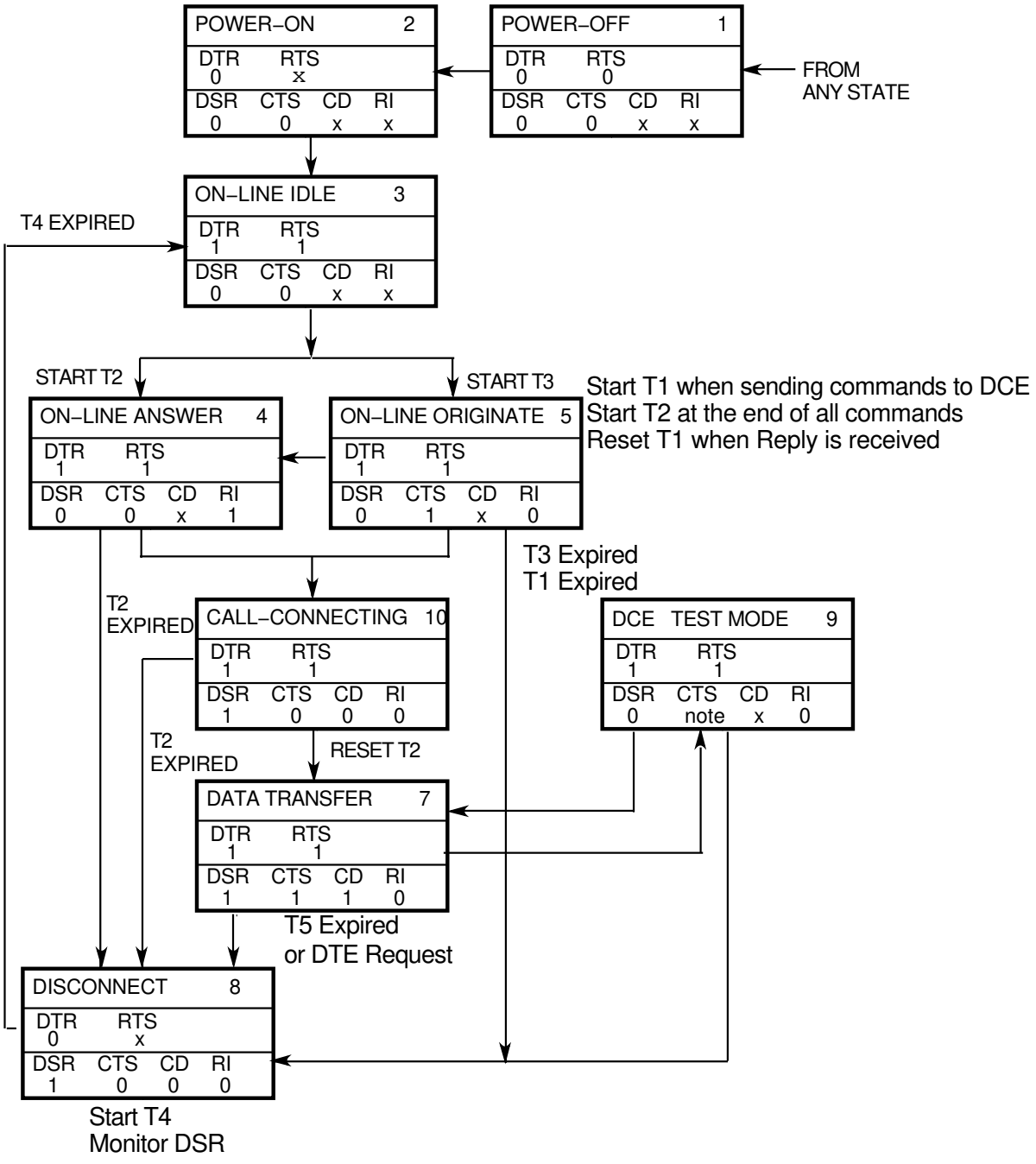


Figure 4: Modem Control for Two-way Simultaneous DTE



3.5 NOTES TO THE STATE DIAGRAM AND EXPLANATIONS

3.5.1 Power-Off State 1

In this state, no power is applied to the driver or receiver circuits of the DTE. Whether power is applied to other portions of the DTE is beyond the scope of this standard.

The DCE will recognize that the DTE is in the Power-off state (using fail-safing, as described in *DEC STD 052-2 Electrical Requirements for Binary Interfaces that Conform to EIA RS-232-C or CCITT V.28 Modems* when either circuit 105_RTS, Request To Send, or circuit 108_DTR, Data Terminal Ready, are detected to be in the off state.

3.5.2 Power-On State 2

During the Power-on sequence, 108_DTR shall be off until the DTE is able to comply with the proper DCE control sequence. In order to avoid DCE control initialization in DCEs that do not use 107_DSR, 105_RTS shall be kept off during power initialization and 103_TD shall be at MARK.

3.5.3 DTE Faults

As long as an internal (DTE) fault exists that prevents proper operation of the DTE-DCE connection or subsequent DTE operation, 108_DTR shall be held off, and therefore, no connection to the line will be made. Faults in the DTE shall be identified by an indicator or procedure.

3.5.4 DTE Off-Line State

In this state, the DTE is being actively used for some purpose that does not allow connection of the DTE to a remote DTE.

Therefore, circuit 108_DTR, Data Terminal Ready, is held off by the DTE; and an on signal on circuit 125_RI, Calling Indicator, if passed from the DCE to the DTE, causes no automatic action. Circuit 125_RI may cause a lamp or other indicator in the DTE to indicate when the circuit is on so that the operator or operating system may take appropriate action.

Off-line may include several substates, such as keyboard to write storage (and display), and read storage to display. Off-line has been referred to as *local mode* in some terminals.

3.5.5 On-Line Idle State 3

In this mode, the DTE has power applied to its interface circuits. The DTE's On-line mode does not imply that the DCE has its link established for the purpose of remote communications. The DTE must recognize the DCE's On-line/Off-line state and allow setup mode of operation.

Circuit 108_DTR, Data Terminal Ready, if provided, shall be on continuously. All circuits provided must conform to the requirements of the operating mode used (full-duplex, half-duplex, and so forth) as specified in this standard.

The DTE remains in the On-line Idle state when no link is present. The transition from Power-on to On-line indicates that the DTE has completed ALL diagnostics, setups, and adjustments successfully. At this point, the client can request service from the DTE.

If directed by the process or client, then the DCE will answer incoming calls when the DTE is connected to the DCE interfacing switched network. In this state, the DCE will signal to the DTE that it can receive commands from the DTE and perform network-addressing functions. The DCE will raise 106_CTS or 106_CTS and 109_CD and will maintain 107_DSR off.

The DTE can enter the Idle state in a number of ways.

- The DCE associated with the DTE is in the Power-off state.
- The DCE associated with the DTE is powered but it operates over a switched network (telephone, data, and so forth) and it needs to establish a physical link (complete dialing out) before any data exchange can take place.
- The physical link between two DCEs is inoperative, and therefore, no communication is possible. This applies to the point-to-point link.
- The DTE waits for a remote DTE to establish a communications link. To exit from the Idle state, the user (client, operator) must make a decision to either enter State 5 and initiate a connection into the remote DTE or enable the DCE to accept an incoming call.

3.5.6 On-Line Originate State 5

Detailed operation of this state is covered in DEC STD 052-3.

NOTE

This state has been added since the last revision of this standard. It has also been incorporated in the latest revision of EIA/TIA-232-E (formerly EIA 232-D). It must be noted that many older types of interfaces, drivers, or client software are not able to cope with the ability to send data to the DCE for the purpose of autodialing, DCE setup, or DCE status. As a result, many DCE vendors have implemented nonstandard handshaking. Such signaling usually results in less than satisfactory operation over switched networks. On the older systems, users had to overcome the problem of not being able to send data for the purpose of autodialing by setting the DTE for Data Leads Only operation. Such a configuration always causes a lot of misbehavior on the switched network and shall be clearly identified as an unsupported configuration. It is the designers' responsibility for new products, or value-engineered products, to include this state in any current or future designs.

This state is quite special in many applications. Often the DTE must operate in two modes. When performing network addressing using a V.24/EIA/TIA-232-E interface, the DTE must act as a "host" and not as a tributary or slave device. When in the Data mode, the DTE may be either master or slave.

In earlier-designed equipment, it was normal to establish the link through operator intervention. Newer communication devices have the ability to perform the operator dial function in both synchronous and start-stop devices. See DEC STD 052-3 for details.

The DCE, if equipped with a V.25 bis style of Autocall, will indicate to the DTE with 106_CTS or with 106_CTS and 109_CD asserted while 107_DSR is off. If the user intends to use this facility, he or she must check the status of 106_CTS after 108_DTR has been set to on. The T3 Timer (1 second) is started and if 106_CTS is not on by the end of T3, the indication is that network services are not available or cannot be provided by the DCE at the present time.

The indication could also mean that this DCE does not conform to the V.25 bis method of control.

The user or client must return to the Idle state and find another means of establishing a communications link. Other means may be manual dial or, on older equipment not having the V.25 bis style of operating, a special dial protocol, such as a DF03 using Control B and numbers for dialing.

If 106_CTS is on before T3 expires, the DTE enters the On-line Originate state. During this state, the information exchange occurs between the DTE and the DCE only. The information may contain DCE configuration, setup, or destination address information for the dialer. The DCE will acknowledge receipt of commands to the DTE. The command structure for international use is specified in DEC STD 052-3. Other command sets used by DCE vendors are not part of this standard. The V.25 bis implementation requires that a 60-second timer be started any time a command is sent to the modem. See DEC STD 052-3.

NOTE

There are few command structures used commonly with DCEs. The Digital Modem Command Language (DMCL) is modeled after DCL structure. The other syntax commonly used by other vendors is the HAYES AT command set. The AT command set was accepted as an industry standard and, in many cases, has been proliferated into a number of implementations and extensions. The implementation of the syntax modeled on one's product does not guarantee that all DCEs that claim compatibility to the AT command set will operate or recognize strings sent by DTE. The details of the AT syntax are not part of this standard. Refer to the Third Edition of *Technical Aspects of Data Communication* by John McNamara, published by Digital Press.

While in the On-line Originate state, there exists a possibility of a collision between the request to place a call and an incoming call. In this case, the DTE must abort the call request, and the DCE will go to the On-line Answer Call State 4. After answering the incoming call, the process or client has an option to reject and abort the connection by forcing State 4 Disconnect.

3.5.7 DCE Setup

The Setup state may be used for the purpose of setting local DCE parameters, as well as for setting up network connections.

When the DCE operates over the PSTN, the DTE shall provide the ability to recognize the Setup state and provide, through the interface, data for the purpose of DCE setup or network addressing (autocalling). Furthermore, the DTE shall recognize when the DCE has established a data link with the remote DCE (local DCE in On-line state). The DTE shall provide facilities to recognize unsuccessful attempts to establish a communications link and provide facilities to clear the request for link establishment. For detailed information, see DEC STD 052-3.

3.5.8 Call-Connecting State 10

The Call-connecting state is a transitional state that exists while the DCE is in the process of establishing the link and performing synchronization between itself and the remote DCE. During that time, the local DCE will not be able to accept any data for transmission, nor receive data from a remote DCE. Any data received by the DTE could be locally generated by the DCE for the purpose of signaling status and it is vendor- and syntax-specific.

In the case where one DCE is equipped with V.42 error-correcting protocol, some benign characters are output for a brief period to the DTE while the remote DCE is trying to establish an error-correcting link. The DTE, if it is set for asynchronous mode of operation, shall ignore those characters and shall not enable an auto-bauding routine. But if the DTE is equipped with auto-bauding routine, it should be activated after entering Data Transfer State 7. The character and operation of V.42 can be found in the CCITT series recommendations.

The Call-connecting state, when automatically initiated through serial protocol or answering state, will be indicated to the DTE by the fact that 107_DSR is transitioning from off to on. The fact that 107_DSR is on does not indicate that the DTE can start sending data to the remote DTE. The only indication 107_DSR provides is that the DCE is connected to the communication channel. There is usually a time period when 106_CTS is off and 109_CD is off. If 106_CTS and 109_CD do not both go on within 60 seconds (False Call Timer expired), Call Disconnect shall be initiated by the DTE and a transition into Disconnect state shall be made. The successful completion of this state is signaled by raising 109_CD and 106_CTS.

3.5.9 Data Transfer State 7

The DCE has successfully completed all synchronization and is ready to transmit data presented on 103_TD and presents valid data to the DTE on 104_RD.

If 107_DSR goes off during the data exchange phase (whether or not data is actually being exchanged), the DTE shall enter the Disconnect state, unless the DTE can detect that the DCE has been put into one of the test modes by the fact that 142_TM is on while 107_DSR is off.

If 109_CD goes off continuously for more than 2 seconds during the data exchange phase, the DTE shall enter the disconnect phase. If a fatal fault occurs in the DTE during the data exchange phase, the DTE shall enter the Disconnect state (if the DTE is still able to do so).

If a switch to Off-line condition is requested by the terminal user or computer operator during the data exchange phase, the DTE shall enter the Disconnect state.

The DTE shall not turn 108_DTR or 105_RTS off until after the last stop bit of a character has been presented to the DCE.

3.5.10 Disconnect State 8

In the Disconnect state, the DTE shall turn 108_DTR off. The DCE will ignore 103_TD and will clamp 104_RD to MARK.

In the Disconnect state, the DTE shall time 2 to 5 seconds minimum, or until 107_DSR goes off. If 107_DSR goes off, the T4 5.0-second Timer is aborted.

After the T4 Disconnect Timer expires, the DTE shall return to the Idle state if no fault exists and Off-line has not been requested. If the Off-line has been requested, or a fault exists, the Off-line (Power-on and 108_DTR off) shall be entered.

If the Idle state is entered, 108_DTR shall be turned on again in anticipation of the next call.

If the process or client is de-assigned from the port, then it is good practice to enter the Off-line state, and keep 108_DTR off until resources are reassigned to the process or client. The 108_DTR in off condition will disable the modem from answering any incoming calls to the DCE.

NOTE

There could be a "trash" character detected if the DCE loses power.

3.6 DATA SIGNALING RATE SELECTOR

The rate selector from the DTE (111_SS) should be used to indicate to the DCE that the higher (when ON) or lower (when OFF) of two predetermined speeds is to be used.

The rate indicator from the DCE (112_SI) should be monitored by the DTE to determine which of two predetermined speeds was selected by the DCE during its handshaking process. (ON = High Speed and OFF = Low Speed)

In DCEs where more than two speeds are possible, a determination must be made at setup time as to which speed is indicated by the high signal and which is indicated by the low signal. Use of a third or other speed is not covered by this standard but may be checked by software or other means.

NOTE

It is a known requirement from Germany that the DTE shall implement circuits 111_SS and 112_SI when intended for connection to V.22 bis modems. A DTE that does not provide circuits 111_SS and 112_SI will not be approved in Germany for connection to V.22 bis modems.

3.7 ADDITIONAL FEATURES

The following additional features are recommended but not required for terminals.

The cable to the DCE may be connected to the DTE by a field-disconnectable connector to facilitate installation and transportation of the DTE. Such a field-disconnectable connector will also facilitate the use of the different modem cable connector-retaining means used by different administrations.

4 POINT-TO-POINT, FULL-DUPLEX OPERATION

4.1 GENERAL

In this section, it is assumed that the DTE with full-modem control is being designed for use with two-way simultaneous asynchronous (up to 19.2 kb/s, V.24/V.28), or synchronous symmetrical transmission, and that all DTE modem signal connections are met.

The point-to-point operation is not exactly a subset of the previous mode. When the DTE has to set up the DCE while it is Off-line (107_DSR off), the DTE has to recognize that it is exchanging information locally and not with a remote DTE. When a human operator is involved, that problem disappears because a person can make decisions based on visual or other feedback received from the DCE. The process or client must have unambiguous conditions, therefore, it is not practical to mix the two modes.

It is possible to use this mode for point-to-point operation and Auto Answer or Manual Originate mode, as was shown in the previous version of this standard. That type of operation is easily recognizable because 107_DSR indicates when the DCE is connected to the communication channel and when data can be transmitted.

4.2 TIMER REQUIREMENTS FOR FULL-DUPLEX, POINT-TO-POINT OPERATION AND THEIR FUNCTIONS

In the point-to-point mode of operation, timer requirements are simpler than when operating in the previous mode.

T5 Carrier Loss Timer 2 seconds-nominal with provision to be set to different times based on national regulations or higher level protocol requirements.

T4 Disconnect Timer 220 ms minimum, 5 seconds maximum

This timer assures that the DTE will drop 108_DTR for a minimum off period of 220 ms to a maximum of 5 seconds, allowing the DCE to disconnect from the telecommunication channel and clear the link. 107_DSR should go to off condition unless it is hardwired. Upon expiration of T4, the DTE enters On-line Idle state.

Figure 5: Modem Control for Full-Duplex, Point-to-Point

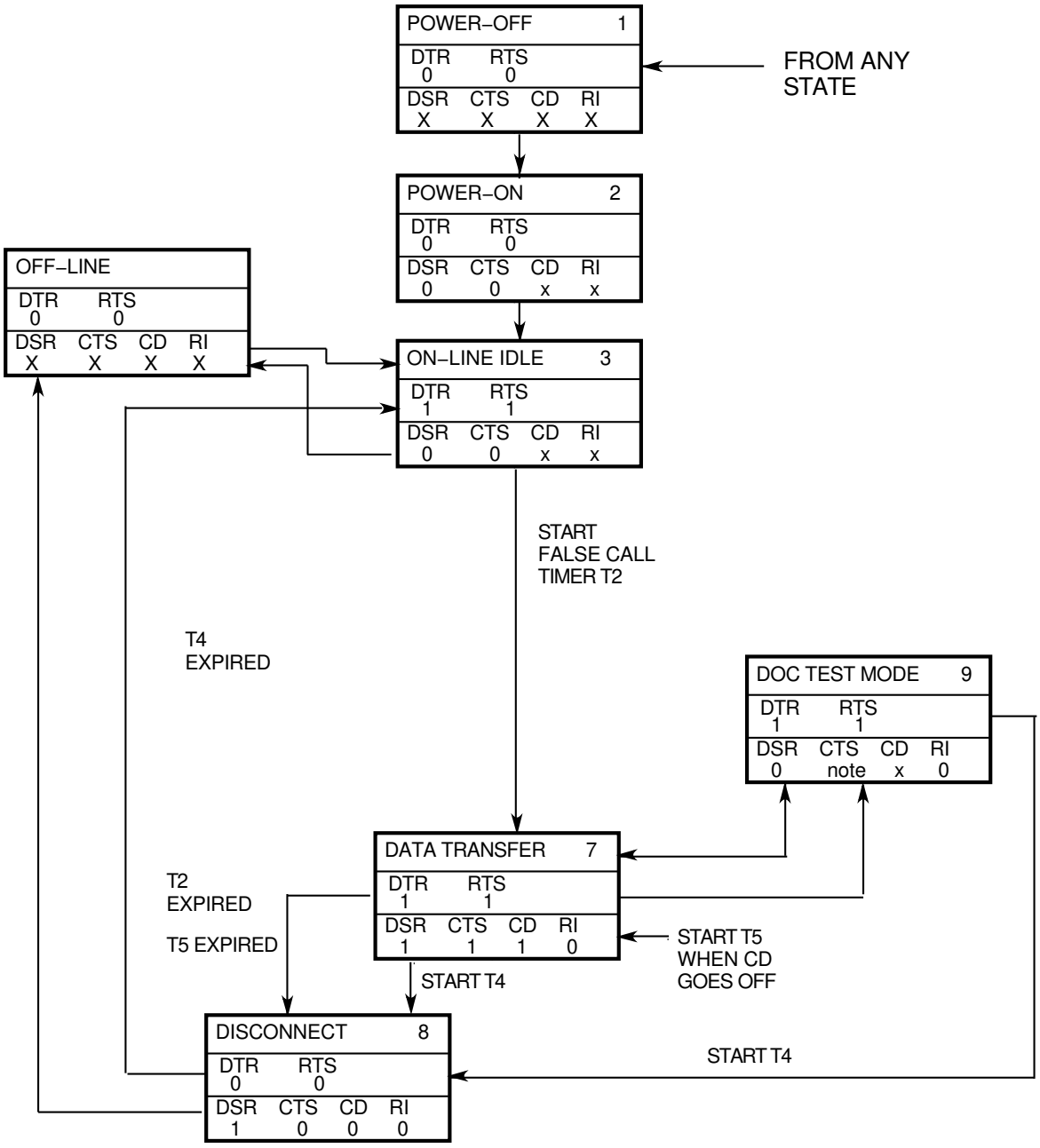


Table 2: State Table for Full-Duplex, Point-to-Point

Old State	New State	Event
Power-off (1)	Power-on (2)	Power is applied to the equipment and interface circuits; internal diagnostics are enabled. All DTE circuits must be in the off state; 103_TD must be at MARK.
Power-on (2)	On-line Idle (3)	Transition to this state is initiated by the DTE. Diagnostics and Initialization procedures are completed. The DTE may be assigned to the process or client. The DTE remains in this state until the DCE is ready to receive data. While the DTE is in this state, the DCE might be performing synchronization with the remote DCE.
On-line Idle (3)	Data Transfer (7)	The DCE causes transition by having both 109_CD and 106_CTS on. The port is ready for data exchange. Transmit when 106_CTS is on; Receive when 109_CD is on.
Data Transfer (7)	DCE Test Mode (9)	The DCE has been put in test mode either by the operator or by the remote command. The client must suspend regular operation and initiate the Diagnostics procedure, if required. 142_TM is on; 107_DSR can be off if the associated DCE is in LOOP 2, or 107_DSR is on if LOOP or LOOP is initiated. See V.54 recommendations for further reference.
Data Transfer (7)	Disconnect (8)	DCE-caused transition: Link failure is detected by 109_CD; off more than 2 seconds. The link is cleared by the DCE. 107_DSR off. DTE-caused transition: The client initiated Port Close procedure. Start the T4 Disconnect Timer. Set 108_DTR to off. Set 103_TD to MARK.
DCE Test (9)	Data Transfer (7)	The DCE completed the Diagnostics procedure or Test procedure. 142_TM is off and allows the client to resume regular operation.
DCE Test (9)	Disconnect (8)	The DCE initiates transition to the Disconnect state by turning off 142_TM and 107_DSR.
Disconnect (8)	On-line Idle (3)	The Close Port procedure is completed. Port resources are de-assigned. The T4 Timer expired. Set 108_DTR to on; 105_RTS to on.

4.2.1 Power-Off State 1

In this state, no power is applied to the driver or receiver circuits of the DTE. Whether power is applied to other portions of the DTE is beyond the scope of this standard.

The DCE will recognize that the DTE is not in ready state (through fail-safing, as described in DEC STD 052-2) when any of circuit 105_RTS (Request To Send) or circuit 108_DTR (Data Terminal Ready) are detected to be in the off state.

4.2.2 Power-On State 2

During the Power-on sequence, 108_DTR shall be off until the DTE is able to comply with the proper DCE control sequence. To avoid DCE control initialization in DCEs that do not use 107_DSR, 105_RTS shall be kept off during power initialization, and 103_TD shall be at MARK.

4.2.3 DTE Faults

As long as an internal (DTE) fault exists that prevents proper operation of the DTE-DCE connection or subsequent DTE operation, 108_DTR shall be held off, and therefore, no connection to the line will be made. Faults in the DTE shall be indicated by an indicator or procedure.

4.2.4 DTE Off-Line State

In this state, the DTE is being actively used for some purpose that does not allow connection of the DTE to a remote DTE.

Therefore, circuit 108_DTR is held off by the DTE, and 103_TD is clamped to MARK.

Off-line may include several substates, such as keyboard to write storage (and display), and read storage to display. Off-line is referred to as *Local* mode in some terminals.

In the case of point-to-point circuits, the DCE will provide status information about the communication channel, informing DTE (client, process) that it is ready to transmit data over a channel. In the point-to-point configuration, the DCE will maintain 107_DSR on and will raise 106_CTS and 109_CD to on after initial synchronization between both DCEs is accomplished.

Such a condition exists when the DCE is powered on or if communication channels exhibit frequent interruption that requires re-synchronization on the part of the DCE. See V.29 recommendation and a description of round-robin retraining.

4.2.5 Off-Line State

In Off-line state, paper may be replaced, adjusted or aligned; margins, form length, character sets, and other parameters may be adjusted; and read media, write media, and read/write media may be changed. In general, any action that is normally performed by the operator and does not require extended periods of time may be performed in this state.

Off-line state is probably applicable only to terminals and not to computer systems.

Whether (and how) entering and exiting Off-line state is signaled to the other end of a connection (usually a computer) is beyond the scope of this standard.

4.2.6 On-line Idle State 3

In this mode, the DTE has power applied to its interface circuits. The DTE's On-line mode does not imply that the DCE has its link established for the purpose of remote communications. The DTE must recognize that the DCE is On-line/Off-line.

Circuit 108_DTR, if provided, shall be on continuously. All circuits provided must conform to the requirements of the operating mode used (full-duplex, half-duplex, and so forth) as specified in this standard.

The On-line Idle state is the state in which the DTE remains when no link is present. The transition from Power-on to On-line indicates that the DTE has completed *all* diagnostics, setups, and adjustments successfully. At this point, the client can request service from the port.

The DTE can enter the Idle state in three ways.

1. The DCE associated with the DTE is in the Power-off state.
2. The physical link between two DCEs is inoperative, and therefore, no communication is possible.
3. The DTE waits for the DCE to establish a communications link.

In high-speed DCEs such as those that comply with Recommendation V.27, V.29, V.33, the action is generated by the DCE without DTE involvement. The DCE will always indicate to the DTE with 106_CTS that it is able to accept data. With 109_CD the DCE will indicate that it has valid data.

4.2.7 Data Transfer State 7

The DCE has successfully completed all synchronization and is ready to transmit and receive data presented on 103_TD and presents valid data to the DTE on 104_RD. The DCE will signal with 106_CTS that it can receive data. With 109_CD the DCE will indicate that it has valid data.

If 107_DSR goes off during the data exchange phase (whether or not data is actually being exchanged), the DTE shall enter the Disconnect state, unless the DTE can detect that the DCE has been put into one of the test modes because 142_TM is on while 107_DSR is off.

If 109_CD goes off continuously for more than 2 seconds during the data exchange phase, the DTE shall enter the Disconnect state. If a fatal fault occurs in the DTE during the data exchange phase, the DTE shall enter the Disconnect state (if the DTE is still able to do so).

If a switch to Off-line condition is requested by the terminal user or computer operator during the data exchange phase, the DTE shall enter the Disconnect state.

The DTE shall not turn 108_DTR or 105_RTS off until after the last Stop bit of a character has been presented to the DCE.

The DTE must stop sending any data to the DCE when 106_CTS is off, and the client must recover from temporary interruption. The way a client will recover from such interruption is not a part of this standard.

4.2.8 Disconnect State 8

In the Disconnect state, the DTE shall turn 108_DTR off. The DCE will ignore 103_TD and will clamp 104_RD to MARK.

In the Disconnect state, the DTE shall time 220 ms minimum, 5 seconds maximum, and test if 107_DSR goes off. A common problem in the point-to-point environment is that 107_DSR does not go off. Therefore, it can be assumed that 107_DSR is hardwired and provides indication that the DCE is in the Power-on state.

After the T4 Disconnect Timer expires, the DTE shall return to the Idle state, if no fault exists, and Off-line has not been requested. If the Off-line has been requested, or a fault exists, the Off-line state shall be entered.

If the Idle state is entered, 108_DTR shall be turned on again in anticipation of the next call.

If the process or client is de-assigned from the port, then it is manatory to enter the Off-line state, and keep 108_DTR off until resources are reassigned to the process or client. The 108_DTR in off condition will disable the modem from answering any incoming calls to the DCE.

5 INTERCHANGE CIRCUIT REQUIREMENTS FOR FULL-DUPLEX OPERATION

Table 3 lists EIA/TIA-232-E/V24-V28 interface assignments and requirements. The connector type is specified in the ISO 2110 specification.

Table 3: EIA/TIA-232-E/V24-V28 Interface Assignments and Requirements

Pin No.	Circuit ID	Name	Comments
2	103_TD	Transmitted Data	
3	104_RD	Received Data	
4	105_RTS	Request To Send	Not always needed in full-duplex modems.
5	106_CTS	Clear To Send	
6	107_DSR	Data Set Ready	
7	102_GND	Signal Ground (common return)	
8	109_CD	Carrier Detect	
20	108_DTR	Data Terminal Ready	
12	112_SI	Speed Indicate	Not always needed in full-duplex modems.
23	111_SS	Speed Select	Not always needed in full-duplex modems.
		Synchronous Operation - Timing is Required	
15	114_TXC	Transmit Clock from the DCE	
17	115_RXC	Receive Clock from the DCE	
24	113_TT	Terminal Timing from the DTE	
		Network Maintenance Signals - Optional	
18	141_LL	Local Loopback	
21	140_RL	Remote Loopback	
25	142_TM	Test Mode	

Table 4 shows pinning requirements for V10/V11 interface implementation. The required connector is specified in ISO 4903 specification.

Table 4: Pinning Requirements for V10/V11 Interface

Pin No.	Circuit ID	Name	Comments
4/22	103_TD	Transmitted Data	
6/24	104_RD	Received Data	
7/25	105_RTS	Request To Send	
9/27	106_CTS	Clear To Send	
11/29	107_DSR	Data Set Ready	
19	102_GND	Signal Ground (common return)	
13/31	109_CD	Carrier Detect	
12/30	108_DTR	Data Terminal Ready	
2	112_SI	Speed Indicate	
16	111_SS	Speed Select	
37	102A_SC	Send Common	
20	102A_RC	Receive Common	
		Synchronous Operation - Timing is Required	
5/23	114_TXC	Transmit Clock from the DCE	
8/26	115_RXC	Receive Clock from the DCE	
17/35	113_TT	Terminal Timing from the DTE	
		Network Maintenance Signals - Optional	
10	141_LL	Local Loopback	
14	140_RL	Remote Loopback	
18	142_TM	Test Mode	

NOTE

The pin numbers, such as 4/22, indicate balanced circuits.

Table 5 specifies pin numbers and circuits for V.35 interface. Note that this type of interface is being phased out in some countries [Germany] in favor of V.36/V10/V11 interface.

Table 5: Pin Numbers and Circuits for V.35 Interface

Pin No.	Circuit ID	Name	Comments
P/S	103_TD	Transmitted Data	
R/T	104_RD	Received Data	
C	105_RTS	Request To Send	
D	106_CTS	Clear To Send	
E	107_DSR	Data Set Ready	
B	102_GND	Signal Ground (common return)	
F	109_CD	Carrier Detect	
H	108_DTR	Data Terminal Ready	
Y/A	114_TXC	Transmit Clock from the DCE	
V/X	115_RXC	Receive Clock from the DCE	
U/W	113_TT	Terminal Timing from the DTE	
		Network Maintenance Signals - Optional	
	141_LL	Local Loopback	
	140_RL	Remote Loopback	
K	142_TM	Test Mode	

6 HALF-DUPLEX (TWO-WAY ALTERNATE)

6.1 GENERAL

A half-duplex method of operation is common in many data systems because the nature of the service is a series of action-reaction sequences in which transmission of data in one direction at a time is all that is required. The half-duplex DTEs operate in a manner such that, when not transmitting, they are monitoring the data transmission channel for received data.

In the half-duplex mode, both DCEs are normally in the receive mode awaiting a signal from another station. There are no line signals on the telecommunication channel to assure continuity of the channel and the presence of the other DCE. The problem is contention because both DCEs may decide to transmit at the same time. The DTE intending to transmit may test the line for circuit assurance prior to transmitting blocks of data. The DTE transmits inquiry and awaits a response before proceeding.

To increase circuit assurance and eliminate contention, the ping-pong method is often used. The method of sending and communicating is normally controlled by the higher level protocol, such as Binary Synchronous Communication Protocol (BISYNC), High-Level Data-Link Control (HDLC), X.25, and Digital Data Communication Message Protocol (DDCMP).

NOTE

In the previous version of this standard there was a configuration of half-duplex mode with 5 baud reverse channel. The use of reverse channels has been rapidly disappearing.

6.2 TIMER REQUIREMENTS FOR HALF-DUPLEX WITH DCE SETUP/PSTN OPERATION

There are a few timers that are required when implementing half-duplex mode intended for operation over PSTN with DCE setup.

T1 Timer 60 seconds ±10% DCE Timeout

This timer is required for operation with autodialing modems, and it is a requirement from Germany. The timer guards against lockup in cases where DCE for some reason will not respond to the command. The DTE will transition through State 8 (Disconnect) and return to On-line Idle state.

T2 Timer 60 seconds ±10% False Call Timer

This timer guards against non-data calls from the DCE. Upon expiration of this timer, DTE transitions through State 8 (Disconnect) into On-line Idle state.

T3 Timer one second ±10% Autocall Timer

This timer protects the DTE from entering into lockup condition when 106_CTS is not raised by the DCE and not allowing autodialing or DCE setup.

T4 Disconnect Timer 5 seconds ±20% Disconnect Timer

This timer assures that the DTE will drop 108_DTR for a period of 5 seconds, allowing the DCE to disconnect from the telecommunication channel, clear the link, and not issue any commands to the DCE during that time. 107_DSR should go to off condition unless it is operating in a nonstandard way. Upon expiration of T4, the DTE enters On-line Idle state.

6.3 STATE TABLES FOR HALF-DUPLEX OPERATION

The state tables in this section refer to the state diagram shown in Figure 6.

Table 8: State Table for Half-Duplex with Network Addressing

Old State	New State	Event
Power-off (1)	Power-on (2)	Power is applied to the equipment and interface circuits; internal diagnostics are enabled. All the DTE circuits must be in the off state; 103_TD must be at MARK.
Power-on (2)	On-line Idle (3)	The DTE causes transition to this state. Diagnostics and Initialization procedures are completed. The port may be assigned to the process or client.
On-line Idle (3)	On-line Answer (4)	The DCE causes transition to this state. The port must be assigned to the client; The Call Answer procedure is initiated.
On-line Idle (3)	On-line Originate (5)	The DTE causes this transition. The port is assigned to the client. The Call Initiate procedure is initiated. The DTE sends commands to the DCE and waits for a reply. The DTE starts the T1 DCE Timeout Timer at the end of command string and resets the T1 Timer when the reply is received from the DCE.
On-line Originate (5)	On-line Answer (4)	125_RI is on. The DCE causes this transition. Call collision is detected; abort the Call Initiate procedure. Initiate the Call Answer procedure. Start the T2 False Call Timer. The DCE will force transition to State 4 and will proceed with execution unless the DTE (process or client) forces transition to Disconnect State 8 by turning off 108_DTR.
On-line Originate (5)	Call-connecting (10)	The DCE causes transition to this state. The Dial-out procedure is completed with success. Initiate the False Call Timer. The DTE monitors 107_DSR, 109_CD, and 106_CTS. Upon completion of the final acknowledgment from the DCE, the DTE starts the False Call Timer T2.
On-line Answer (4)	Call-connecting (10)	The DCE causes transition to this state. The Answer procedure is completed; initiate the T2 False Call Timer; 107_DSR comes on. The DTE monitors 106_CTS and 109_CD.

Table 8 (Cont.): State Table for Half-Duplex with Network Addressing

Old State	New State	Event
Call-connecting (10)	Data Transfer (7)	The DCE causes transition to this state. Transmit when 106_CTS is on; Receive when 109_CD is on. The protocol module determines direction and state sequence.
Data Transfer (7)	Transmit Enable (7T1)	The DTE controls this transition. The DTE turns on 105_RTS if 109_CD is off, and awaits 106_CTS before transitioning to State 7T2. The DTE starts the T1 Timer and waits for 106_CTS.
Transmit Enable (7T1)	Disconnect (7T2)	The T1 Timer expired before the DCE raised 106_CTS. (A DCE fault is detected.)
Data Transfer (7)	Receive Enable (7R1)	The protocol module controls this state. All timing functions are embedded and the abort function is part of the Protocol. The DTE waits for 109_CD to come on before transitioning into Receiving state.
Transmit Enable (7T1)	Transmitting (7T2)	The DCE has turned 106_CTS. The DTE can transmit data on 103_TD.
Receive Enable (7R1)	Receiving (7R2)	The DCE raised 109_CD and presented valid data to DTE. The data is being passed to the protocol module.
Transmitting (7T2)	Data Transfer (7)	The DTE has completed transmission of the data block/packet. The DTE turns 105_RTS to off and sets 103_TD to MARK.
Receiving (7R2)	Data Transfer (7)	The DCE turned 109_CD to off. The DTE has to complete the Receiving state and enter the Data Transfer state.
Data Transfer (7)	DCE Test Mode (9)	The DCE has been put in test mode, either by the operator or by the remote command. The client must suspend regular operation and initiate the Diagnostics procedure, if required. 142_TM is on; 107_DSR can be off.
DCE Test Mode (9)	Data Transfer (7)	The DCE has completed the Diagnostics procedure or Test procedure; 142_TM is off and allows the client to resume regular operation.
Call-connecting (10)	Disconnect (8)	The False Call or False Answer Timer is expired. The connection is unsuccessful or Call Originate/Answer procedures are unsuccessful.

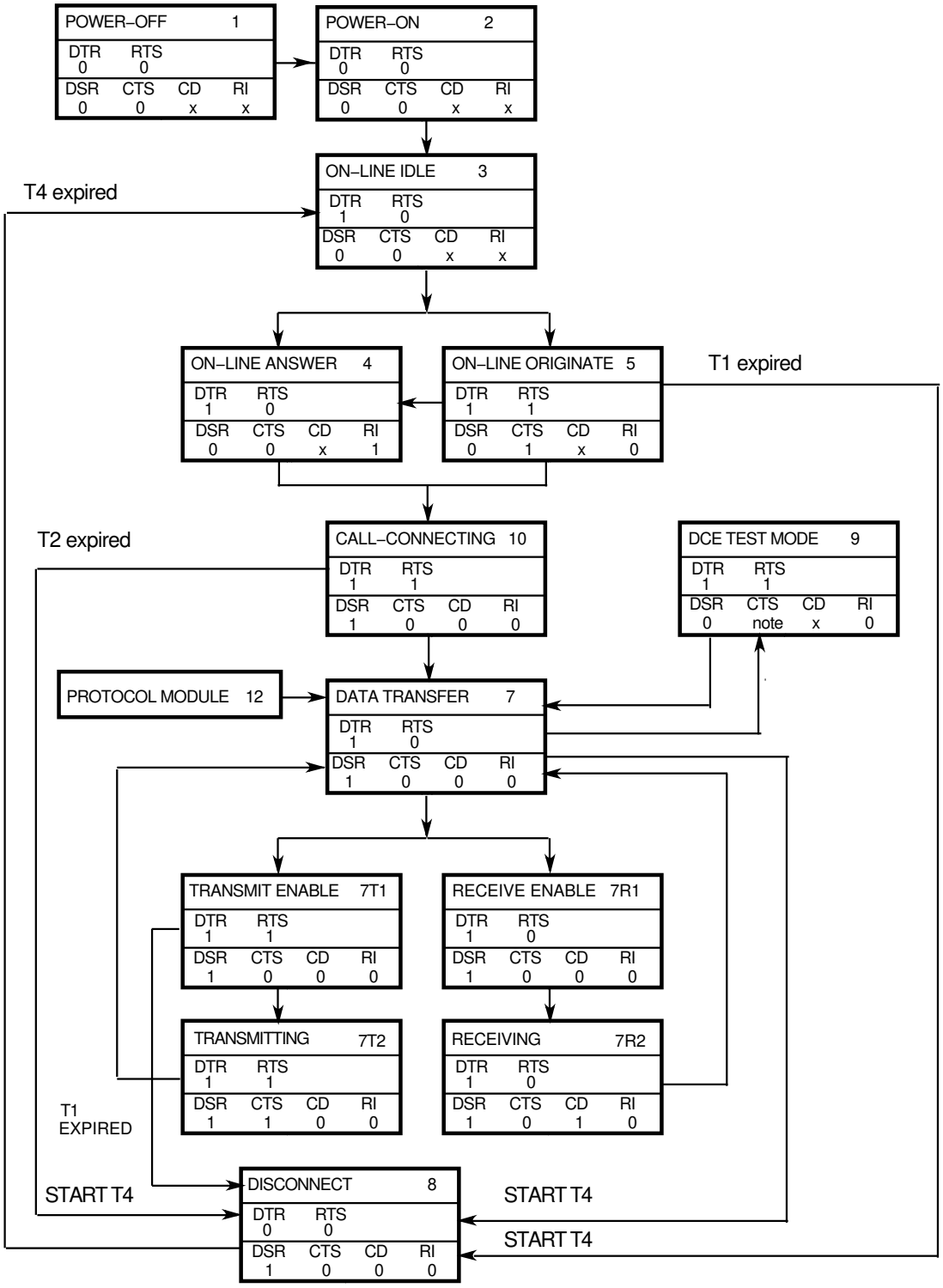
Table 8 (Cont.): State Table for Half-Duplex with Network Addressing

Old State	New State	Event
Data Transfer (7)	Disconnect (8)	The link is cleared by the DCE. 107_DSR off. The client initiated the Port Close procedure. Start the T4 Disconnect Timer (5 seconds). Set 108_DTR to off. Set 103_TD to MARK.
Disconnect (8)	On-line Idle (3)	The Close Port procedure is completed. Port resources are de-assigned. The T4 Timer is expired. 108_DTR is set to on; 106_CTS is set to off.

NOTE

A calling DCE has the initial right to transmit when the DCE operates over the PSTN. The answering DCE must enter initial Receive state first.

Figure 6: State Diagram for Half-Duplex



6.4 STATE DIAGRAM - OVERVIEW

The state diagram in Figure 6 represents the essential parts of the half-duplex operation; it presents information about control leads between the DTE and the DCE. The signal states are being shown in the bottom part of the box. The *1* indicates that the particular signal is on (TRUE), the *0* indicates that the particular signal is off (FALSE), and a symbol *x* indicates *don't care* condition.

6.4.1 Power-Off State (DTE Only)

In the Power-off state, all interface leads are in the off state. It is the responsibility of the designer to follow DEC STD 052-2 and provide fail-safe operation for the following leads: (107_DSR, 106_CTS). In this state, the DTE is not capable of providing any operation.

6.4.2 Power-On State

During the Power-on sequence, 108_DTR shall be off until the DTE is able to comply with the proper modem control sequence. The 103_TD signal shall be clamped to MARK.

Any data that might appear on Received Data 103_TD shall be ignored until the port is assigned to process and 109_CD is on. The transition from Power-on to Idle state signifies that the DTE is ready to establish a data link.

6.4.3 DTE Faults

As long as an internal (DTE) fault exists that prevents proper operation of the DTE-DCE connection or subsequent DTE operation, 108_DTR shall be held off, and therefore, no connection to the line will be made. Faults in the DTE shall be identified by an indicator or procedure.

In half-duplex operation, the interface operation is characterized in the flow diagram. It is also assumed that higher level protocol is used over physical links, such as BISYNC, DDCMP, HDLC, and X.25.

The timer and turnaround decisions are made by protocol module, and those must be implemented per relevant protocol specification.

State 2 is entered when the DTE performs internal test and setup and is not ready to accept data. The DTE enters State 3 whenever it is ready to establish a logical link.

Before entering State 7 or State 4, the DTE goes over the protocol setup, which is beyond the scope of this standard. The protocol determines initial Transmit or Receive state. The DTE cannot enter State 7 or State 4 if 107_DSR is not present and, therefore, shall not transmit or receive any data. 107_DSR off means that the DCE does not have a physical channel or is in a Power-off condition. The Retrial Timer is the particular protocol implementation.

6.4.4 On-Line Idle State 3

The On-line Idle state is the state in which the DTE remains when no link is present. The DTE can enter that state in several ways.

1. The DCE associated with the DTE is in the Power-off state.
2. The DCE associated with the DTE is in the Power-on state but it operates over a switched network (telephone, packet, or whatever).

3. The physical link between two DCEs is down, and therefore, no communication is possible.
4. The DCE waits for the remote DCE to establish the communication link.

To exit from that state the user (application, operator) must make a decision to either enter State 5 and initiate connection into the remote DTE, or enable the DCE to accept incoming calls. The methods of enabling the DCE to accept incoming calls are not a subject of this standard.

6.4.5 On-Line Originate State 5

State 5 Network Addressing

The Data Transfer mode in half-duplex encompasses two distinct modes, either Transmit or Receive mode, but not both at the same time.

In the older equipment, it was normal to establish a link by operator intervention and remove that burden from the DTE. The newer communication devices have the ability to perform that function in both asynchronous and synchronous environments. See DEC STD 052-3 for detailed information on international syntax and protocol used in both environments.

Currently there are two synchronous protocols specified, one using BISYNC framing, and a second using HDLC. Those are specified in V.25 bis CCITT recommendation. The Digital protocol uses DMCL with the BISYNC framing.

This state has been simplified. See DEC STD 052-3 for details of the DCE setup and network-addressing functions. The DCE, if equipped with such functions, will indicate to the DTE with 106_CTS asserted and/or with 106_CTS and 109_CD asserted, when 107_DSR is in the off state.

If the user intends to use those facilities, he or she must check the status of 106_CTS after 108_DTR has been raised. The T1 Timer 200 MS ±50 ms (CTS Timer) is started if 106_CTS is not in the on state by the time it indicates that network services are not available or cannot be provided at that time. The user must abort and return to the Idle state and find other means of establishing a communication link, using operator intervention.

If 106_CTS is up before T1 expires, the DTE enters Network-addressing state. During that state, the information exchange occurs between the DTE and the DCE only. That information can contain configuration, setup, or destination address for the DCE to call.

The DCE will acknowledge receipt of commands back to the DTE. The command structure for international use is specified in DEC STD 052-3. Other command sets used by DCE vendors are not part of this standard, and the vendor specification should be consulted if the designer chooses to implement a special command syntax.

While in this state, a collision is possible between the DTE initiating request to establish link with a remote DTE and an incoming call. The DTE must abort any call request and proceed into the Answer Call state.

6.4.6 On-Line Answer State 4

The Answer Call state is entered when the DCE provides 125_RI (ring indicate to the DTE). This, in the majority of applications, is not latched and usually follows a cadence of ring signals present in the PSTN. The range of those cadences is from 200 ms on to 2 seconds on with an off interval of 4 to 10 seconds. Refer to *DEC STD 053-0 Interface Between Data Circuit-Termination Equipment and Public Switched Telephone Network (PSTN) in the US and Canada* and *DEC STD 053-1 Interface Between Data Circuit-Terminating Equipment and the Public Switched Telephone Network (PSTN) - Worldwide* for specific country information.

When the DTE recognizes 125_RI, it starts the False Call Timer. If the DTE was in the process of sending commands to the DCE for the purpose of setup or autodial, it must abort that function.

It is the DTE function to decide if it wants to proceed with answering incoming call, or to abort answering by entering Disconnect state with 108_DTR off.

107_DSR is the next interchange signal that the DCE will assert, and the DCE will enter the Call-connecting state. The DTE enters into Data mode, and based on user protocol requirements, enters into either the Enable Receive or the Enable Transmit state. The user planning to enter Transmit mode should raise 105_RTS and start T2 to await 106_CTS to be asserted by the DCE.

6.4.7 Call-Connecting State 10

Call-connecting is a transitional state during which the DCE establishes synchronization with the remote DCE. The time required for synchronization depends on the DCE type. See relevant CCITT V series recommendation.

6.4.8 Protocol Module

The protocol setup is not part of this standard and normally the protocol establishes initial transmit or receive directions. Also, depending on the protocol, it establishes timers associated with turnaround delays, frame credits, and so forth.

6.4.9 Receive Enable State 7R1

The DTE enters the Receive Enable state after completing sending data to the remote DCE. The DTE starts a timer, normally specified by the protocol, and awaits reply from the remote DTE. The local DCE will indicate with 109_CD that it has valid data.

6.4.10 Receiving State 7R2

This state is entered when DCE raises 109_CD and presents valid data to the DTE. The received data from the interface is being passed to the protocol module for processing. When the DCE turns off 109_CD, the DTE leaves this state.

6.4.11 Transmit Enable State 7T1

The DTE enters Enable Transmit state if there is no 109_CD present. The DTE raises 105_RTS, starts T1 2-second Timer, and awaits 106_CTS to be asserted by the DCE. The 105_RTS to 106_CTS time varies drastically from DCE to DCE. Shortest times are in the range of milliseconds and some others can be as long as 2 seconds for initial training and synchronization. The DTE starts the T1 timer and waits for 106_CTS to come on. When 106_CTS is asserted by the DCE, the DTE enters Transmitting state.

6.4.12 Transmitting State 7T2

The DTE is allowed to transmit data to the remote end by the fact that 106_CTS is on. The DTE aborts the T Timer. While in this state, the DTE must monitor 107_DSR and 106_CTS while data transfer occurs.

6.4.13 Data Mode Receive

The DTE enters this mode either initially or because protocol requires acknowledgment. The data received is valid as long as 109_CD is on. When 109_CD goes off, the DTE disables its Receive state. While in this state, the DTE monitors 107_DSR and 109_CD.

6.4.14 Disable Receive State

This state is entered when 109_CD goes off. The user can decide at this time whether the session with the remote DTE is over and enter Disconnect state. If the session is supposed to continue, the user would disable its Receive state and start enabling its Transmit state.

6.4.15 Disconnect State 8

This state is entered in two ways.

1. The user completes the session, DTE drops 108_DTR.
2. The DCE dropped 107_DSR, signifying that the link is disconnected.

6.5 INTERFACE SIGNAL REQUIREMENTS

In this section, it is assumed that a DTE with full-modem control is being designed for use with two-way alternate half-duplex, asynchronous (EIA/TIA-232-E, V24/V28) or synchronous (EIA/TIA-232-E, V24/V28, V10, V11, V.35) transmission.

For electrical requirements for V24/V28/EIA/TIA-232-E, see DEC STD 052-0. For electrical requirements for V10, V11, and V.35, see CCITT Blue Book, Volume VIII.

For the specification of the connector used, see:

- ISO 2110 for connector used with EIA/TIA-232-E, V24/V28
- ISO 4903 for connector used with V10 recommendation
- Circuit implementation and pin assignment for ISO 2110 connector

Pin No.	Circuit ID	Name	Comments
2	103_TD	Transmitted Data	
3	104_RD	Received Data	
4	105_RTS	Request To Send	Always needed in half-duplex modems.
5	106_CTS	Clear To Send	
6	107_DSR	Data Set Ready	
7	102_GND	Signal Ground (common return)	
8	109_CD	Carrier Detect	
20	108_DTR	Data Terminal Ready	
22	125_RI	Ring Indicate (Call Indicate)	Required for dial operation.
12	112_SI	Speed Indicate	
23	111_SS	Speed Select	
15	114_TXC	Transmit Clock from the DCE	
17	115_RXC	Receive Clock from the DCE	
24	113_TT	Terminal Timing from the DTE	
		Network Maintenance Signals (Optional)	
18	141_LL	Local Loopback	
21	140_RL	Remote Loopback	
25	142_TM	Test Mode	

NOTE

Table 7 shows pinning requirements for V10/V11 interface implementation. The required connector is specified in the ISO 4903 specification.

Table 7: Interface Signals for EIA-449

Pin No.	Circuit ID	Name	Comments
4/22	103_TD	Transmitted Data	
6/24	104_RD	Received Data	
7/25	105_RTS	Request To Send	
9/27	106_CTS	Clear To Send	
11/29	107_DSR	Data Set Ready	
19	102_GND	Signal Ground (common return)	
13/31	109_CD	Carrier Detect	
12/30	108_DTR	Data Terminal Ready	
37	102A_SC	Send Common	
20	102B_RC	Receive Common	
		Synchronous Operation - Timing is Required	
5/23	114_TXC	Transmit Clock from the DCE	
8/26	115_RXC	Receive Clock from the DCE	
17/35	113_TT	Terminal Timing from the DTE	
		Network Maintenance Signals - Optional	
10	141_LL	Local Loopback	
14	140_RL	Remote Loopback	
18	142_TM	Test Mode	
2	112_SI	Speed Indicate	
16	111_SS	Speed Select	

NOTE

The pin numbers, such as 4/22, indicate balanced circuits.

7 POINT-TO-POINT OPERATION

7.1 GENERAL

The Timing Default Diagram requirements are illustrated per Figure 8. Point-to-point operation occurs when a physical link is established at the time of installation. This situation is true when the DCE operates over leased lines. As a result, the state and flow diagrams are simplified because there is no need for a physical link establishment procedure or associated recognition of additional states.

7.2 TIMER REQUIREMENTS FOR POINT-TO-POINT, HALF-DUPLEX OPERATION

T1 CTS Timer 5 seconds ±20%

The DTE starts this timer while waiting for 106_CTS to turn on. This timer guards against DCE faults.

T4 Disconnect Timer 220 ms ±20%

This timer causes 108_DTR to drop when entering Disconnect state.

NOTE

In previous versions of this standard, other timers that were required are not needed because they interfered with link layer protocol. The link layer protocols have built-in timers or other means to maintain link integrity.

The 30-second timer for no-receive data is not needed, especially in point-to-point environment.

Figure 7: State Diagram for Half-Duplex, Point-to-Point Operation

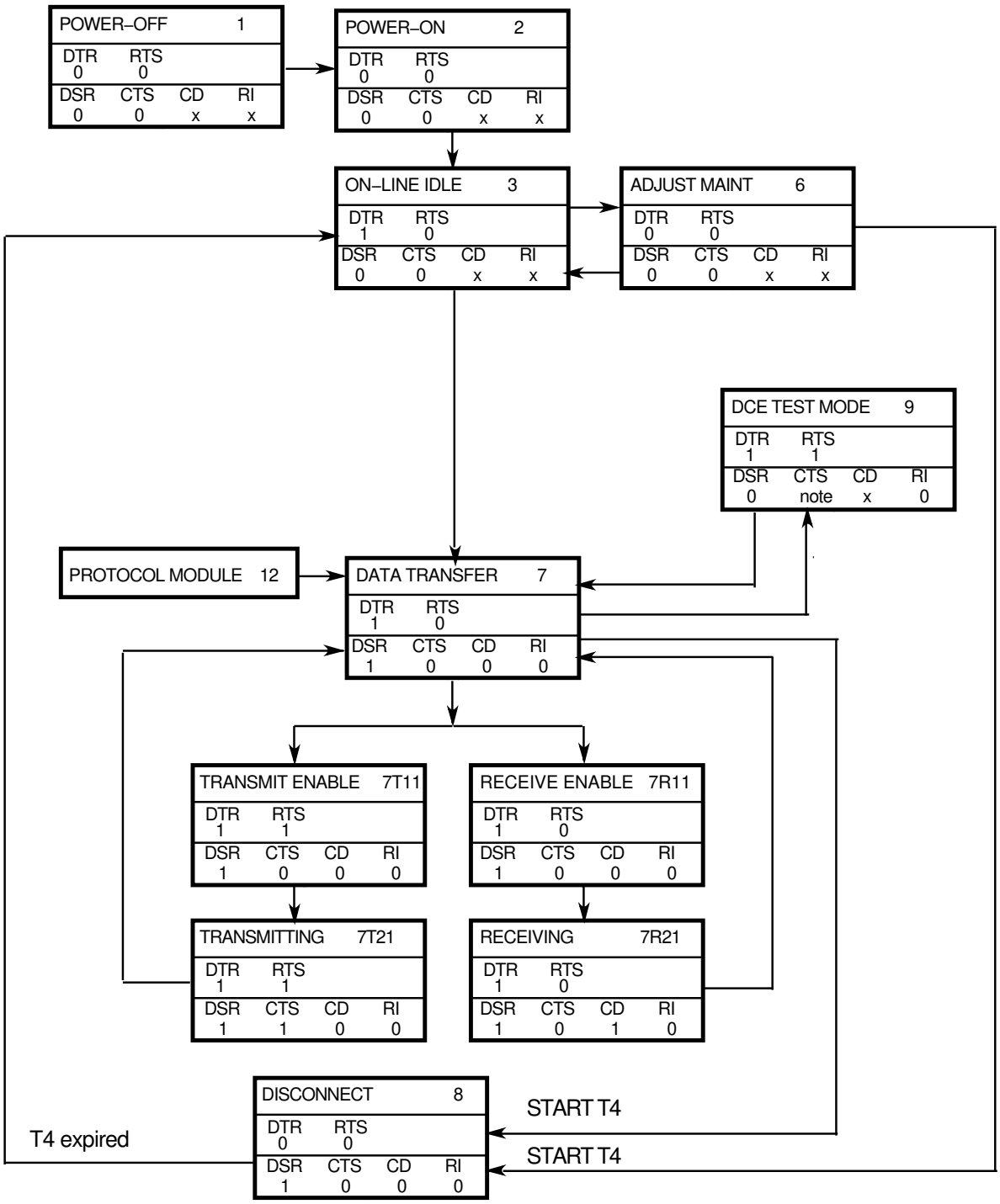


Table 8: State Table for Half-Duplex

Old State	New State	Event
Power-off (1)	Power-on (2)	Power is applied to the equipment and interface circuits; internal diagnostics are enabled. All DTE circuits must be in the off state; the 103_TD must be in at MARK.
Power-on (2)	On-line Idle (3)	The DTE causes transition to this state. Diagnostics and Initialization procedures are completed. The port may be assigned to process or client.
On-line Idle (3)	Data Transfer (7)	The DCE causes transition to this state. Transmit when 106_CTS is on; Receive when 109_CD is on. The protocol module determines direction and state sequence.
Data Transfer (7)	Transmit Enable (7T1)	The DTE controls this transition. The DTE turns on 105_RTS if 109_CD is off and awaits 106_CTS before transitioning to State 7T2. The DTE starts the T1 Timer.
Transmit Enable	Disconnect	T1 Timer expires. The DTE senses a fault with the DCE and enters the Disconnect state.
Data Transfer (7)	Receive Enable (7R1)	Transition is caused by the protocol module. The DTE waits for 109_CD to turn on.
Transmit Enable (7T1)	Transmitting (7T2)	The DCE has turned on 106_CTS. The DTE can transmit data on 103_TD.
Receive Enable (7R1)	Receiving (7R2)	The DCE turned on 109_CD and has valid data on 104_RD. The data is passed to the protocol module.
Transmitting (7T2)	Data Transfer (7)	The DTE has completed transmission of the data block/packet. The DTE turns 105_RTS to off and sets 103_TD to MARK.
Receiving (7R2)	Data Transfer (7)	The DCE turns 109_CD to off and clamps 104_RD to MARK.
Data Transfer (7)	DCE Test Mode (9)	The DCE has been put in test mode, either by the operator or by the remote command. The client must suspend regular operation and initiate the Diagnostics procedure, if required. 142_TM is on. 107_DSR can be off if the associated DCE is in LOOP 2. See CCITT V.54 recommendations for further reference.

Table 8 (Cont.): State Table for Half-Duplex

Old State	New State	Event
DCE Test Mode (9)	Data Transfer (7)	The DCE completed the Diagnostics procedure or Test procedure. 142_TM is off and allows the client to resume regular operation.
Call-connecting (10)	Disconnect (8)	The False Call or False Answer Timer is expired. The connection is unsuccessful or Call Originate/Answer procedures are unsuccessful.
Data Mode Transfer (7)	Disconnect	The link is cleared by the DCE. 107_DSR off. The client initiated Port Close procedure. Start the T4 Disconnect Timer (220 ms). Set 108_DTR to off. Set 103_TD to MARK.
Disconnect (8)	On-line Idle (3)	The Close Port procedure is completed. Port resources are de-assigned. The T4 Timer is expired. 108_DTR is set to on; 106_CTS is set to off.

NOTE

A calling DCE has the initial right to transmit when the DCE operates over the PSTN. The answering DCE must enter initial Receive state first.

7.3 STATE DIAGRAM - OVERVIEW

The state diagram shown in Figure 7 represents the essential parts of the half-duplex operation. Information is presented about control leads between the DTE and the DCE. The signal states are being shown in the bottom part of the box. The *1* indicates that the particular signal is on (TRUE), the *0* indicates that the particular signal is off (FALSE), and a symbol *x* indicates a *don't care* condition.

7.3.1 Power-Off State

In the Power-off state, all interface leads are in the off state. The designer's responsibility is to follow DEC STD 052-2 and provide fail-safe operation for the following leads: DTE side (DSR, CTS). In this state, the DTE is not capable of providing any operation.

7.3.2 Power-On State

During the Power-on sequence, 108_DTR shall be off until the DTE is able to comply with the proper modem control sequence. The 103_TD shall be clamped to MARK.

Any data that might appear on Received Data 103_TD shall be ignored until the port is assigned to a process and 109_CD is on. The transition from Power-on to Idle state signifies that the DTE is ready to establish a data link.

7.3.3 DTE Faults

As long as an internal (DTE) fault exists that prevents proper operation of the DTE-DCE connection or subsequent DTE operation, 108_DTR shall be held off. Therefore, no connection to the line will be made. Faults in the DTE shall be identified by an indicator or procedure.

In half-duplex operation, the interface operation is characterized in the flow diagram. It is also assumed that higher level protocol is used over physical links such as BISYNC, DDCMP, HDLC, and X.25.

State 2 is entered when DTE performs internal test and setup and is not ready to accept data. The DTE enters State 3 whenever it is ready to establish a logical link.

Before entering State 7 or 4, the DTE goes over the protocol setup, which is beyond the scope of this standard. The protocol determines initial Transmit or Receive state. The DTE cannot enter State 7 or 4 if 107_DSR is not present and, therefore, shall not transmit or receive any data. 107_DSR off means that the DCE does not have a physical channel or is in a Power-off condition. The Retrial Timer is the particular protocol implementation.

7.3.4 On-Line Idle State 3

The On-line Idle state is the state in which the DTE remains when no link is present. The DTE can enter that state in several ways.

1. The DCE associated with the DTE is in the Power-off state.
2. The DCE associated with the DTE is in the Power-on state, but it operates over switched network (telephone, packet, and whatever).
3. The physical link between two DCEs is down, and therefore, no communication is possible.
4. The DCE waits for the remote DCE to establish a communication link.

To exit from that state, the user (application, operator) must make a decision to either enter State 9 and initiate connection into the remote DTE, or enable the DCE to accept the incoming call. The methods of enabling DCEs to accept incoming calls are not a subject of this standard.

7.3.5 On-Line Originate State 5

This state is mainly applicable for a primary or master, rather than a tributary, device.

The Data Transfer mode in half-duplex encompasses two distinct modes, either Transmit or Receive mode, but not both at the same time.

In older equipment, it was normal to establish the link using operator intervention, thereby removing that burden from the DTE. Newer communication devices have the ability to perform that function in both asynchronous and synchronous environments. See DEC STD 052-3 for detailed information on international syntax and protocol used in both environments.

Currently, there are two synchronous protocols specified; one using BISYNC framing and a second using HDLC. Those protocols are specified in V.25 bis CCITT recommendation. The Digital protocol uses DMCL language with the BISYNC framing.

This state has been simplified. See DEC STD 052-3 for details of the DCE setup and the network-addressing functions. The DCE, if equipped with such functions, will indicate to the DTE with 106_CTS asserted and/or with 106_CTS and 109_CD asserted, when 107_DSR is in the off state.

If the user intends to use those facilities, he or she must check the status of 106_CTS after 108_DTR has been raised. The T1 Timer 200 ms ±50 ms (CTS Timer) is started if 106_CTS is not in the on state by the time it indicates that network services are not available or cannot be provided at that time. The user must abort and return to the Idle state and find another means of establishing a communication link, using operator intervention.

If 106_CTS is up before T1 expires, the DTE enters Network-addressing state. During that state, the information exchange occurs between the DTE and the DCE only. That information can contain configuration, setup, or destination address for the DCE to call.

The DCE will acknowledge receipt of commands back to the DTE. The command structure for international use is specified in DEC STD 052-3. Other command sets used by DCE vendors are not part of this standard, and the vendor specification should be consulted if the designer chooses to implement a special command syntax.

While in this state, it is possible to have a collision between the DTE initiating a request to establish a link with a remote DTE and an incoming call. The DTE must abort any call request and proceed to the Answer Call state.

7.3.6 On-Line Answer State 4

The Answer Call state is entered when the DCE provides 125_RI (ring indicate to the DTE). This, in the majority of applications, is not latched and usually follows a cadence of ring signals present in the PSTN. The range of those cadences are from 200 ms on to 2 seconds on with an off interval of 4 to 10 seconds. See DEC STDs 053-0 and 053-1 for country-specific information.

When the DTE recognizes 125_RI, it starts the False Call Timer. If the DTE was in the process of sending commands to the DCE for the purpose of setup or autodial, it must abort that function.

The DTE's function is to decide if it wants to proceed with answering the incoming call or abort answering by entering Disconnect state with 108_DTR off.

107_DSR is the next interchange signal that the DCE will assert, and the DCE will enter the Call-connecting state. The DTE enters into Data mode, and based on user protocol requirements, enters into either the Enable Receive or the Enable Transmit state. The user planning to enter Transmit mode should raise 105_RTS and start T2 to await 106_CTS to be asserted by the DCE.

7.3.7 Call-Connecting State 10

Call-connecting State 10 is a transitional state during which the DCE establishes synchronization with the remote DCE. The time required for synchronization depends on the DCE type. See relevant CCITT V series recommendations.

7.3.8 Protocol Module

The protocol setup is not part of this standard, and normally the protocol establishes initial transmit or receive directions. Also, depending on the protocol, the setup establishes timers associated with turnaround delays, frame credits, and whatever.

7.3.9 Receive Enable State 7R1

The DTE enters this state after sending data to the remote DCE. The DTE starts a timer that is normally specified by the protocol and awaits reply from the remote DTE. The local DCE will indicate with 109_CD that it has valid data.

7.3.10 Receiving State 7R2

This state is entered when the DCE raises 109_CD and presents valid data to the DTE. The received data from the interface is being passed to the protocol module for processing. When the DCE turns off 109_CD, the DTE leaves this state.

7.3.11 Transmit Enable State 7T1

The DTE enters Enable Transmit state if there is no 109_CD present. The DTE raises 105_RTS and starts T1 2-second Timer, and awaits 106_CTS to be asserted by the DCE. The 105_RTS to 106_CTS time varies drastically from DCE to DCE. Shortest times are in the range of milliseconds and others can be as long as 2 seconds for initial training and synchronization. When 106_CTS is asserted by the DCE, the DTE enters Transmitting state.

7.3.12 Transmitting State 7T2

The DTE is allowed to transmit data to the remote end by the fact that 106_CTS is on. In this state, the DTE must monitor 107_DSR and 106_CTS while data transfer occurs.

7.3.13 Data Mode Receive

The DTE enters this mode either initially or because protocols require acknowledgment. The data received is valid as long as 109_CD is on. When 109_CD goes off, the DTE disables its Receive state. While in this state, the DTE monitors 107_DSR and 109_CD.

7.3.14 Disable Receive State

This state is entered when 109_CD goes off. The user can decide at this time whether the session with the remote DTE is over and enter the Disconnect state. If the session is supposed to continue, the user would disable its Receive state and start enabling its Transmit state.

7.3.15 Disconnect State 8

This state is entered in the following ways.

1. The user completes the session.
2. The DCE dropped 107_DSR, signifying that the link is disconnected.

7.4 INTERFACE SIGNAL REQUIREMENTS

In this section it is assumed that a DTE with full-modem control is being designed for use with two-way alternate half-duplex, asynchronous (EIA/TIA-232-E, V24/V28) or synchronous (EIA/TIA-232-E, V24/V28, V10, V11, V.35) transmission.

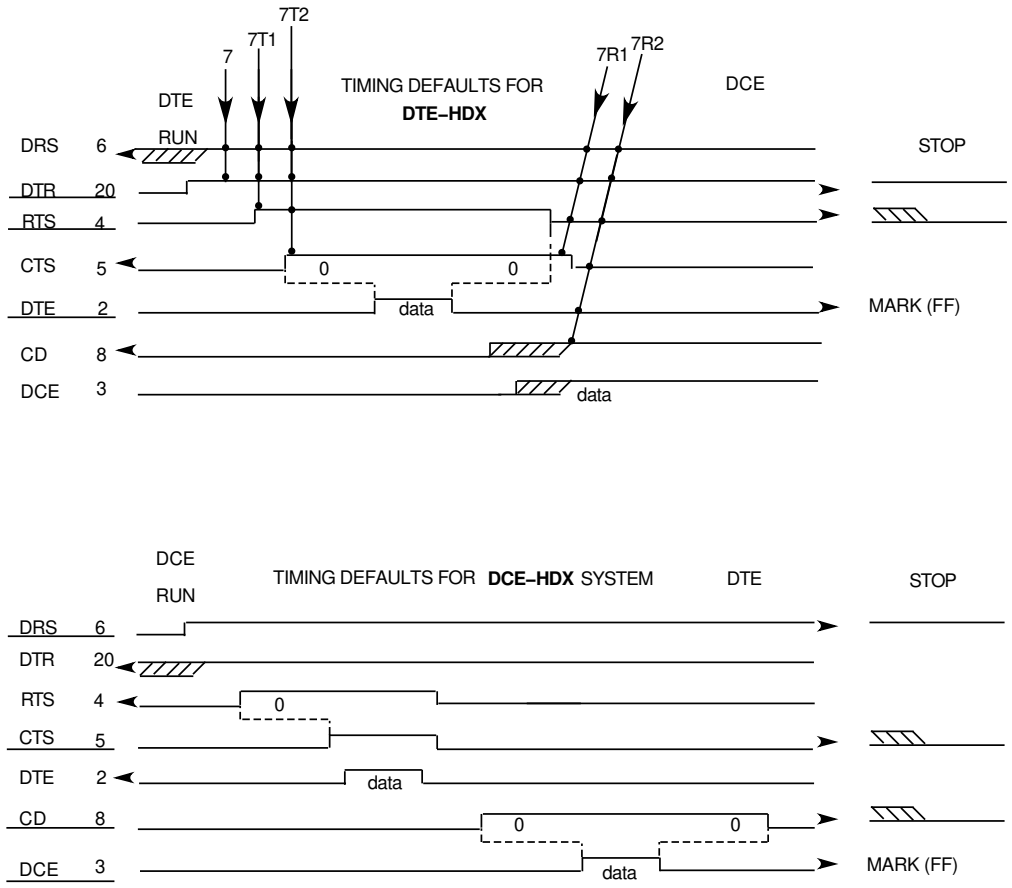
For electrical requirements for V24/V28/EIA/TIA-232-E, see DEC STD 052-0. For electrical requirements for V.10 and V.11, see CCITT Blue Book, Volume VIII.

For the specification of the connector used, see:

- ISO 2110 for connector used with EIA/TIA-232-E and V24/V28
- ISO 4903 for connector used with V.10 recommendation
- Circuit implementation and pin assignment for ISO 2110 connector

Pin No.	Circuit ID	Name	Comments
2	103_TD	Transmitted Data	
3	104_RD	Received Data	
4	105_RTS	Request to Send	Always needed in half-duplex modems.
5	106_CTS	Clear to Send	
6	107_DSR	Data Set Ready	
7	102_GND	Signal Ground (common return)	
8	109_CD	Carrier Detect	
20	108_DTR	Data Terminal Ready	
22	125_RI	Ring Indicate (Call Indicate)	Required for dial operation.
12	112_SI	Speed Indicate	
23	111_SS	Speed Select	
		Synchronous Operation - Clocks Required	
15	114_TXC	Transmit Clock from the DCE	
17	115_RXC	Receive Clock from the DCE	
24	113_TT	Terminal-timing from the DTE	Optional
		Network Maintenance Signals (Optional)	
18	141_LL	Local Loopback	
21	140_RL	Remote Loopback	
25	142_TM	Test Mode	

Figure 8: Timing Default Diagram



8 MULTIPOINT

8.1 GENERAL

Multipoint is a configuration in which more than two DCEs share a common transmission path. Multipoint contains a number of combinations of topology. Figures 9 and 10 show three possible configurations for multipoint.

1. Primary DCE full-duplex, secondaries half-duplex.
2. Both primary and secondary half-duplex.
3. Both primary and secondaries full-duplex.

Figure 9: Multipoint, Primary Full-Duplex, Secondaries Half-Duplex

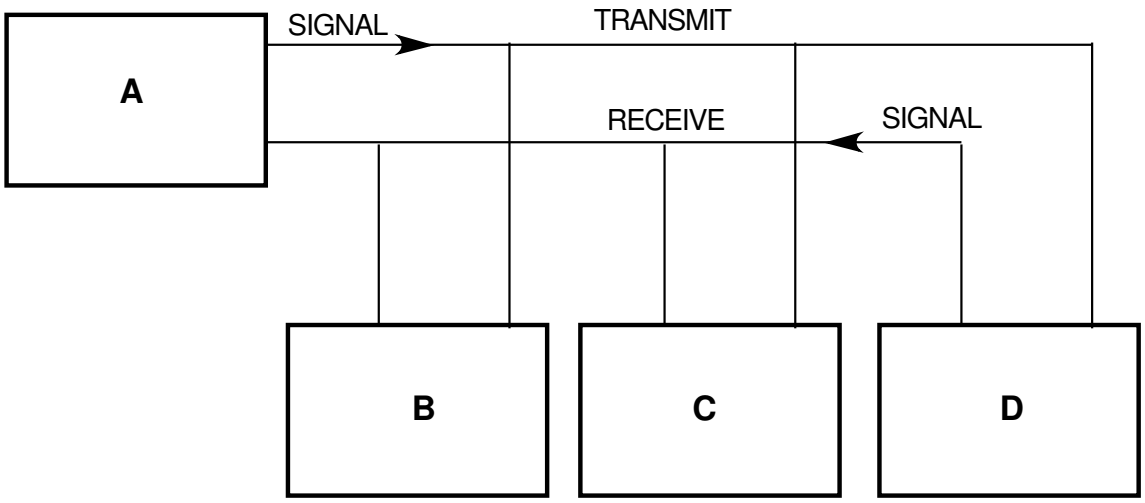
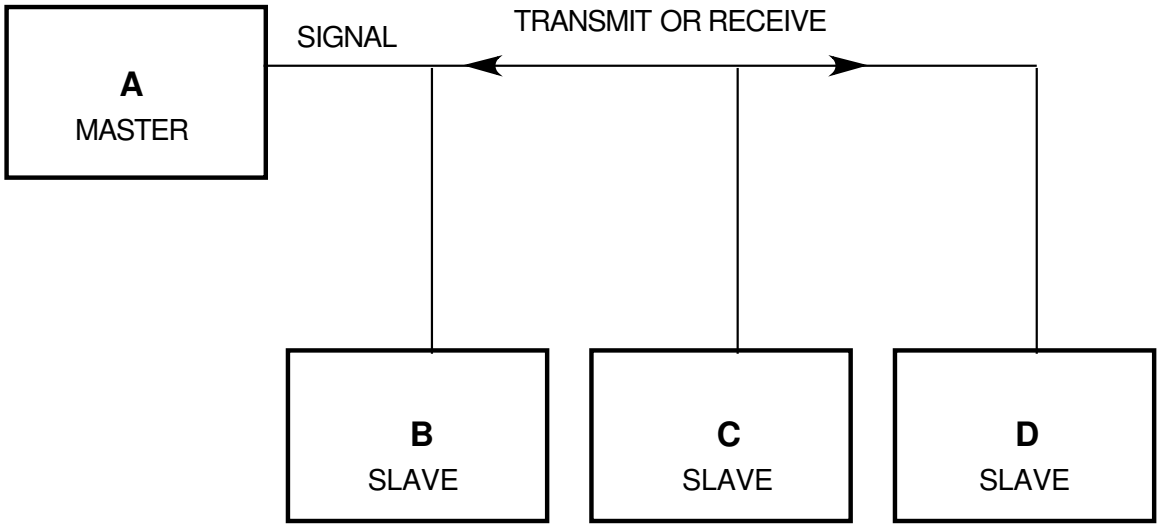


Figure 10: Multipoint, Primary and Secondaries Half-Duplex



The choice of line protocol for multipoint links depends primarily on whether there is a designated primary station or not. When there is a primary station, data are exchanged only between a primary and a secondary, not between two secondaries. The most common protocol used is *poll and select*.

Primary Requests Data from Secondary — The secondary has data and informs the primary that data is coming. If the secondary does not have data, it sends NAC response.

The most common operation in multipoint network is *roll-call polling*, in which a primary selectively polls each secondary in a predetermined sequence.

The characteristic common to all multipoint line protocols is the need for addressing.

8.1.1 Multipoint Master

The multipoint master configuration operates in full-duplex, point-to-point mode. In such a case, the master has to implement the state diagram for full-duplex, point-to-point operation. The state diagram is outlined in Figure 5.

The multipoint master that operates in half-duplex, point-to-point operation must implement the state diagram as outlined in the half-duplex, point-to-point, Figure 7.

8.1.2 Multipoint Slave

The multipoint slave normally will operate in half-duplex point-to point environment. The protocol module will control link integrity, and must implement the half-duplex state diagram as outlined in Figure 6.

In this operation, the protocol module will override the requirement not to transmit when 109_CD is on, which is a half-duplex, point-to-point requirement.

8.2 INTERCHANGE CIRCUITS REQUIRED

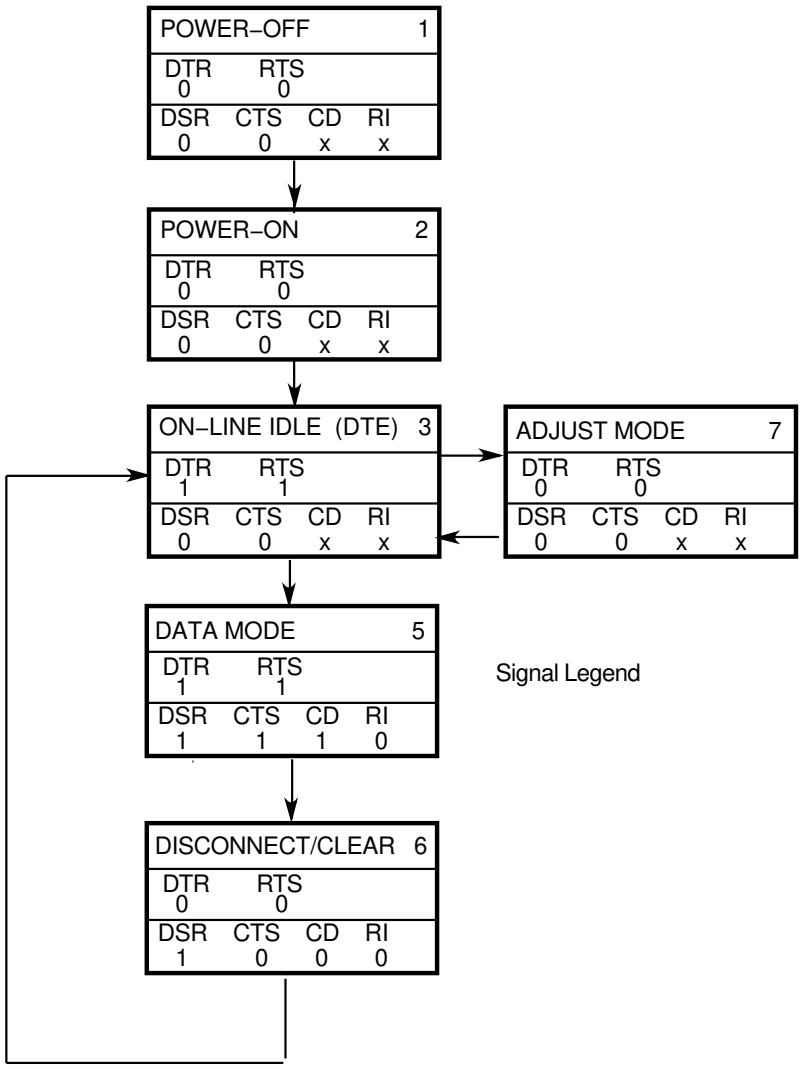
Table 9: Multipoint Interface Signals and Pinouts

Pin No.	Name	Comments
2	103_TD	Transmitted Data
3	104_RD	Received Data
4	105_RTS	Request to Send
5	106_CTS	Clear to Send
6	107_DSR	Data Set Ready
7	102_GND	Signal Ground (Common)
8	109_CD	Carrier Detect
20	108_DTR	Data Terminal Ready
		Synchronous Operation - Clocks Required
15	114_TXC	Transmit Clock
17	115_RXC	Receive Clock
24	113_TT	Terminal-timing (Optional)
		Network Maintenance Signals (Optional)
18	141_LL	Local Loop
21	140_RL	Remote Loop
25	142_TM	Test Mode

9 DATA LEADS ONLY

9.1 GENERAL OVERVIEW

Figure 11: Flow Diagram - Data Leads Only



The notes in the flow diagrams indicate that some equipment called Data Leads Only may require these signals to be forced. See subhead 9.2. The DTE assumes that the physical connection is on and ready to accept data. The DTE always provides DTR and does not perform any test of control leads.

When this mode is used with DCEs (control leads forced in modem), the DCE should be placed where an operator can oversee the operation; there is no disconnect process.

9.2 DATA LEADS ONLY

In this situation, the DTE operates as if it is holding circuit 105_RTS and 108_DTR on, and the DCE is holding 106_CTS, 107_DSR, and 109_CD on, even though none of these signals actually passes across the interface.

The Data Leads Only mode is used in direct connection between the computer system and the terminal (null modem applications), with some limited distance modems, in some leased line applications, and with data-only multiplexers.

To receive and transmit the data in synchronous mode, a clock signal has to be present on pins 15 and 17 of the DTEs. This mode exists in one of the following situations:

- When the system interface and the terminal are connected without modems, or
- When the DTE is in Maintenance loop.

The connection can be made by supplying an external clock to pins 15 and 17. This can be done in many different ways, but the recommended wiring arrangement is to provide each DTE with a clock signal 113_TT (pin 24) Terminal Timing. A connection is then made from pin 24 to pin 15 (114_TXC) of the same DTE and to pin 17 (115_RXC) of the other DTE. A second method is to use a nonpassive null modem providing a clock circuit to both DTEs.

9.3 INTERCHANGE CIRCUITS REQUIRED

Pin No.	Circuit ID	Name	Comments
2	103_TD	Transmitted Data	
3	104_RD	Received Data	
7	102_GND	Signal Ground (Common)	
		Synchronous Mode Requires Clock Leads in Addition to Above	
15	114_TXC	Transmit Clock	
17	115_RXC	Receive Clock	

10 BIT RATES AND STOP ELEMENTS

The bit rates and corresponding Stop bit requirements and recommendations for asynchronous, character-by-character communications are given in the following subheads. The maximum speed required is the highest allowable speed of the product under consideration. Therefore, a 30-character per second hard copy terminal is not required to operate at a speed greater than 300 bits per second (assuming 10-bit characters). The product under consideration may also operate at speeds in excess of its "natural" speed. Refer to *DEC STD 070-12 Video Systems Reference Manual — Terminal Synchronization* for a method to avoid overrunning the DTE's capacity to absorb data.

The DTEs to which this standard applies shall operate correctly with any received stop element that is one-half of a nominal bit duration or longer.

The receiving portion of DTEs to which this standard applies shall provide a minimum tolerance to distortion (consisting of both bit rate variability due to tolerance in the bit rate of the transmitting portion of the transmitting DTE and bit edge position variability due to the transmitting DTE to both modems and to the circuit between modems) of 40%.

Data bit lengths from DTEs affected by this standard shall be within +1% to -2.5% of the nominal. Example: At 1200 bits per second, each signal element shall be 833.3 (841.7 to 812.5) microseconds.

10.1 BIT RATE SELECTION

Operation may be provided at the following rates with the following number of stop bits.

Table 10: Bit Rate Selection

Transmitted from the DTE		Received by the DTE bps	Nominal Bit Duration	Notes
bps	Stop Unit			
50	1.5 or 2	50	20.0 ms	[1]
75	1 or 2	75	13.34 ms	First Choice
110	1 or 2	110	9.09 ms	Second Choice
150	1 or 2	150	6.67 ms	Second Choice
300	1 or 2	300	3.33 ms	First Choice
600	1 or 2	600	1.67 ms	First Choice
1200	1 or 2	1200	833 µs	First Choice
1200	1 or 2	1200	833 µs	First Choice
1800	1	1800	556 µs	Second Choice
2400	1	2400	417 µs	First Choice
3600	1	3600	278 µs	Second Choice
4800	1	4800	208 µs	First Choice
7200	1	7200	138.8 µs	Second Choice
9600	1	9600	104.2 µs	First Choice
12000	1	12000	83.3 µs	
14400	1	14400	69.4 µs	
19200	1	19200	52.1 µs	First Choice

[1] 50 bits per second is listed here to cover some very old telex types of equipment. It is expected that this will have limited application.

Speeds above 2400 bps should be integer multiples of 600.

The speeds indicated with *First Choice* may be implemented first, in order of increasing speed, up to the maximum speed that is relevant for the particular device. Allocation of *Second Choice* speeds is done in any required order. For example, 7200 bits per second can be selected if a device can support this speed, but is unable to support 9600 bits per second.

In two-way simultaneous asymmetrical mode, the DTE transmits at one speed and receives at another. For this mode of operation, the DTE at the terminal end transmits at a lower speed and receives at a higher speed. Conversely, at the computer end, the DTE receives at a lower speed and transmits at a higher speed. For more details, refer to subhead 5. Accuracy of the clock shall be within +1% to -2.5%.

The speeds listed here are for interfaces complying with V24/EIA/TIA-232-E.

10.2 HIGH-SPEED DATA RATES ABOVE 19200 BPS

As of the release date of this standard, there were following **synchronous** speed rates observed in DCE types of equipment. The equipment operates normally in point-to-point, full-duplex synchronous mode. The associated interface is either V.35 or V.10, V.11, or V.36 per the CCITT Blue Book.

Speed in kb/s: 24, 28.8, 32, 38.4, 48, 56 (DDS speed), 57.6, 64 (DDS speed), 72, 76.8, 84, 96, 112, 115.2, 128, 144, 168, 192, 224, 230.4, 256, 288, 336, 384, 448, 512, 672, 768, 772, 896, 1024, 1344 (CCITT T1 rate) (US T1 data rate), 1536, 1920 (CCITT "E1" rate).

NOTE

In general it is required to provide rates and 64 kb/s for interface that support rates above 64 kb/s.

APPENDIX A MANUAL CALL ESTABLISHMENT OPERATION

Manually answered calls: The terminal user or computer operator has the responsibility to verify that the called or calling station is a modem (and not a telephone user).

Manually originated calls: The terminal user or computer operator has the responsibility to ensure that the called modem answers before the operator passes control to the terminal or computer interface.

Further, the terminal user or computer operator has the responsibility to verify that a usable connection has been established (for example, by successfully logging into the computer system), and that a usable connection continues to exist (for example, by obtaining reasonable responses to his or her inputs).

If all these conditions are not satisfied, the operator shall disconnect the call and retry the call (in the case of origination) a limited number of times before notifying the computer system operator (or the administration) of the failure. Failure to obtain a reasonable response within 30 to 60 seconds shall cause the operator to disconnect the call.

In cases where a call is originated or answered manually, but the data transfer does not involve the terminal user or computer operator directly, it shall be the responsibility of the data transfer protocol to disconnect the call or, alternately, to notify the user or operator so that he may disconnect the call when the protocol fails to obtain a reasonable response within 30 to 60 seconds.

The responsible design engineer of the terminal has the responsibility to ensure that the above information is included in the terminal's operating instructions.

The responsible (software) design engineer of the computer interface software (which provides manual operation) has the responsibility to ensure that the above information is included in the computer operator's instructions.

APPENDIX B MODEM CONTROL SIGNAL LEADS

ISO 2110 Connector Pin No.	Source	Interchange Circuit Name CCITT V.24	DEC Abbr.	CCITT V.24 Circuit No.	EIA/TIA -232-E	DIN 66020 Blatt 1
1	- -	(Protective Ground)		(101)	(AA)	(E1)
2	DTE	Transmitted Data	TD	103	BA	D1
3	DCE	Received Data	RD	104	BB	D2
4	DTE	Request to Send	RTS	105	CA	S2
5	DCE	Ready for Sending	CTS	106	CB	M2
6	DCE	Data Set Ready	DSR	107	CC	M1
7	- -	Signal Ground/Return	SIG GND	102	AB	E2
8	DCE	Data Channel Received Line[1]	CD	109	CF	M5
9	- -	Reserved - Test Point	- -	- -	- -	- -
10	- -	Reserved - Test Point	- -	- -	- -	- -
11	- -		- -	- -	- -	- -
12	DCE	Data Signal Rate Select DCE[2]	SI	112	CI	M4
20	DTE	Data Terminal Ready	DTR	108.2	CD	S1.2
22	DCE	Calling (Ring) Indicate	RI	125	CE	M3
23	DTE	Data Signal Rate Select DTE[3]	SS	111	CR	S4
The following circuits are added for interface of synchronous communication.						
15	DCE	Transmit Signal Element-timing	TXC	114	DB	T2
17	DCE	Receive Signal Element-timing	RXC	115	DD	T4
24	DTE	Transmit Signal-timing DTE[4]	TT	113	DA	T1
The following circuits are used for network maintenance and support						
18	DTE	Local Loopback	LL	141	LL	PS3
21	DTE	Remote Loopback	RL	140	RI	PS2
25	DCE	Test Mode Indicate	TM	142	TM	PM1

[1]Called Carrier Detect Signal Detect

[2]Called Speed Indicate

[3]Called Speed Select

[4]Also known as Terminal-timing

NOTE

Pins 18, 21, and 25 may have circuits that conflict with signals on older equipment.

NOTE

Pin 1 is assigned for connecting the shields between tandem sections of shielded interface cable. The shield may be connected to either Protective Ground or to Signal Ground at either the DTE or DCE or both, in accordance with national regulations.

Signal Ground may be further connected to Protective Ground in accordance with national safety regulations. Caution should be exercised to prevent establishment of ground loops carrying high currents.

A recommended method of establishing a reference without causing ground loops is to place a 100-ohm, 0.5 watt resistor between Pin 1 (101_GND) and Pin 7 (102_SIG GND). A jumper should be placed across the 100-ohm resistor to allow:

0 ohms between 101 and 102.
100 ohms between 101 and 102
Open between 101 and 102

This arrangement complies with local regulations and/or solves local grounding problems.

B.1 MODEM CONTROL LEADS

Table 11: CCITT Interchange Circuit Numbers and Names

CCITT V.24	Interchange Circuit Name (CCITT V.24)	Source	EIA	DIN	DEC Abbrev.
(101)	Protective Ground	—	AA	E1	PRT GND
102	Signal Ground or Common Return	—	AB	E2	SIG GND
103	Transmitted Data	DTE	BA	D1	TD
104	Received Data	DCE	BB	D2	RD
105	Request to Send	DTE	CA	S2	RTS
106	Ready for Sending (Clear to Send)	DCE	CB	M2	CTS
107	Data Set Ready	DCE	CC	M1	DSR
108.1	Connect Data Set to Line	DTE	—	S1.1	CDSTL
108.2	Data Terminal Ready	DTE	CD	S1.2	DTR
109	Data Channel Received Line Signal Dectector (Carrier Detect)	DCE	CF	M5	CD
110	Data Signal Quality	DCE	CG	M6	SIG QUAL
111	Data Signaling Rate Selector (Speed Select)	DTE	CH	S4	SS
112	Data Signaling Rate Selector (Speed Mode Indicate)	DCE	CI	M4	SI
113	Transmitter Signal Element Timing (Terminal Timing)	DTE	DA	T1	TT
114	Transmitter Signal Element Timing - DCE	DCE	DB	T2	TXC
115	Receiver Signal Element Timing - DCE	DCE	DD	T4	RXC
118	Transmitted Backward Channel Data	DTE	SBA	D1	SEC TD
119	Received Backward Channel Data	DCE	SBB	HD2	SEC RD
120	Transmit Backward Channel Line Signal	DTE	SCA	HS2	SRTS
121	Backward Channel Ready	DCE	SCB	HM2	SCTS
122	Backward Channel Received Line Signal	DCE	SCF	HM5	SCD
125	Calling Indicator	DCE	CE	M3	RI
126	Select Transmit Frequency	DTE	—	S5	SEL TXF
127	Select Receive Frequency	DTE	—	S6	SEL RXF
140	Remote Loopback	DTE	RL	PS2	RL
141	Local Loopback	DTE	LL	PS3	LL
142	Test Indicate	DCE	TM	PM1	TM

NOTE

Circuit numbers 118 through 122, 126, and 127 are not used in Digital equipment and are listed here for reference.

B.2 MODEM CONTROL SIGNAL LEADS

NOTE

Pins 18, 21, and 25 may have circuits that conflict with signals on older equipment.

NOTE

Pin 1 is assigned for connecting the shields between tandem sections of shielded interface cable. The shield may be connected either to protective ground or to signal ground at either the DTE or DCE or both in accordance with national regulations.

Signal ground may be further connected to protective ground in accordance with national safety regulations. Caution should be exercised to prevent establishment of ground loops carrying high currents.

A recommended method of establishing a reference without causing ground loops is to place a 100-ohm, 0.5 watt resistor between Pin 1 (101_GND) and Pin 7 (102_SIGGND). A jumper should be placed across the 100-ohm resistor to allow:

0 ohms between 101 and 102
100 ohms between 101 and 102
Open between 101 and 102

This arrangement complies with local regulations and/or solves local grounding problems.

APPENDIX C REFERENCED DOCUMENTS

C.1 EL-Class Digital Documents

EL-Class Number	Document Title
EL-00052-00	*DEC STD 052-0 Operational Requirements for Serial Terminals and Computer Interfaces Operating as DTEs Connected to EIA RS-232-C or CCITT V.28 Modems*
EL-00052-02	*DEC STD 052-2 Electrical Requirements for Binary Interfaces That Conform to EIA RS-232-C or CCITT V.28 Modems*
EL-00052-03	*DEC STD 052-3 Automatic Calling and/or Answering Equipment on the GSTN Using the 100 Series Interchange Circuits*
EL-00052-04	*DEC STD 052-4 Local Direct Connection (no Modem) for Serial Asynchronous Terminals and System Interfaces*
EL-00053-00	*DEC STD 053-0 Interface Between Data Circuit-Termination Equipment and Public Switched Telephone Network (PSTN) in the U.S. and Canada*
EL-00053-01	*DEC STD 053-1 Interface Between Data Circuit-Terminating Equipment and the Public Switched Telephone Network (PSTN) - Worldwide*
EL-00060-00	*DEC STD 060-0 Design of Hardware Products to National and International Regulations and Standards, Policies and Procedures*
EL-00062-00	*DEC STD 062-0 Product Submittal to Regulatory Agencies*
EL-00062-02	*DEC STD 062-2 German EMI Certification/Approval Process*
EL-00070-12	*DEC STD 070-12 Video Systems Reference Manual - Terminal Synchronization*
EL-SM498-00	*Producing International Products Reference Set*

Use VTX SMC to order copies of EL-class documents from Standards and Methods Control. Send distribution questions to JOKUR::SMC or call DTN: 234-4423.

C.2 Other Digital Documents

Document Number	Document Title
	DECnet Digital Network Architecture Modem Connect Functional Specification

C.3 Other Documents

Document Number	Document Title
CCITT-V.10	*International Telegraph/Telephone Consultative Committee - Electrical Characteristics for unbalanced double-current interchange circuits for general use with integrated circuit equipment in the field of data communication*
CCITT-V.11	*International Telegraph/Telephone Consultative Committee - Electrical characteristics for balanced double-current interchange circuits for general use with integrated circuit equipment in the field of data communication*

Document Number	Document Title
CCITT-V.24	*International Telegraph/Telephone Consultative Committee - List of definitions for interchange circuits between data terminal equipment (DTE) and data circuit terminating equipment (DCE)*
CCITT-V.25 BIS	*International Telegraph/Telephone Consultative Committee - Automatic calling and/or answering equipment on the general switched telephone network (GSTN) using the 100-series interchange circuits*
CCITT-V.28	*International Telegraph/Telephone Consultative Committee - Electrical characteristics for unbalanced double-current interchange circuits*
CCITT-V.35	*International Telegraph/Telephone Consultative Committee - Data Transmission at 48 kilobits per second using 60-108 kHz group band circuits*
CCITT-V.36	*International Telegraph/Telephone Consultative Committee - Modems for synchronous data transmission using 60-108 kHz group band circuits*
CCITT-V.54	*International Telegraph/Telephone Consultative Committee - Loop test devices for modems*
EIA/TIA-232-E	*Interface Between Data Terminal Equipment and Data Circuit - Terminating Equipment Employing Serial Binary Data Interchange*
ISO-2110	*International Standard Organization - Data communication - 25-pin DTE/DCE interface connector and pin assignments*
ISO-4902	*International Standard Organization - Data communication - 37-pin and 9-pin DTE/DCE interface connectors and pin assignments*
ISO-4903	*International Standard Organization - Data communication - 15-pin DTE/DCE interface connector and pin assignments*

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